SCIENCE

VOL. 89 FRIDAY, JANUARY 20, 1939 No. 2299

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal
Lancaster, Pa. Garrison, N. Y.
Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

THE CELL AND THE PROBLEM OF ORGANIZATION[1]

By Professor EDMUND W. SINNOTT

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THE third decade of the nineteenth century may well be regarded as the period in which the science of biology began to assume its modern form. The great conceptions of protoplasm as the physical basis of life, of the cell as the unit of plant and animal structure and of the nucleus as an integral part of the cell were then taking shape in the minds of biologists and were beginning to receive their first published expression. My predecessor of seven years ago celebrated the discovery of the nucleus by Robert Brown in 1831. The present year is generally accepted as marking the centennial of a still more important biological idea, that the cell is the unit of structure in all organisms. It was just one hundred years ago that Schleiden's famous paper was published. We need not attempt here to determine what part of the credit for the formulation of the cell theory should be given to Schleiden and Schwann and how much to earlier students of the minute structure of living things. The year 1838 is at least a convenient point from which to measure a century, and 1938 thus provides a natural occasion on which to evaluate the theory in terms of present-day biology. Such is the purpose of a number of scientific programs, at this meeting of the American Association and elsewhere.

It is not my intention here to undertake the ambitious task of reviewing the significant part which the cell theory has played in the history of morphology, physiology, genetics and indeed of every biological discipline. I do propose, however, to discuss briefly with you certain of its implications for one particular field—that most baffling of biological enigmas, the problem of the organized development of living things. An organism is not static. It continually changes, but in such a regular and orderly fashion

[1] Address of the retiring president of the Botanical Society of America at Richmond, Virginia, December 29, 1938.

that we must recognize in this developmental process the operation of a constant control. The wealth of knowledge which biologists have acquired about plants and animals has thrown surprisingly little light on what this control is or how it is exercised. To watch a fertilized egg or a tiny primordium march unfalteringly onward until the ultimate form of complex organ or body has been attained is an experience common enough among biologists, but it can not fail to impress the thoughtful observer with a sense of his ignorance. Until we shall discover what is really happening in this mass of developing protoplasm, what molding and morphogenetic processes are here so subtly at work, our knowledge of living things will still be merely superficial. This is the biologist's frontier. Beyond is undiscovered country into whose borders a few explorers have penetrated here and there just far enough to see how broad and fertile the land is and how well protected against those who seek to enter it.

It is to this problem of organic development, of course, that the cell theory has made one of its major contributions. To understand that growth is accomplished chiefly by the multiplication of essentially uniform cellular elements and that changes in external form and internal structure are related to differences in the rate and plane of cell division and in modification of the characters of the cells themselves, is evidently to take a long and hopeful step along the road toward a knowledge of the process of development. But we must sadly admit that the hopes raised by this first triumph have not been altogether realized. The developmental relations between cells and the higher structures which they compose are still unknown. The extreme proponents of the cell theory regard the organism essentially as a colony of cellular individuals and attribute the phenomena of development to complex interactions between these units. At the other extreme are the organismalists, who agree that "the cells do not make the body but the body makes the cells." Both admit the significance of cellular organization as either a primary or a secondary factor, but neither has been able to interpret the phenomena of development in any simple or comprehensible terms. The body admittedly is built of cellular units, but the mechanism which controls the multiplication of these units and builds from them before our eyes the amazingly complex organic edifice entirely eludes observation. The most enthusiastic proponent of the cell theory must admit as much.

In an attempt to solve this problem biologists have carried still further the methods of analysis which led to the great generalization which we celebrate to-day. The rather nebulous genetic factors postulated by Mendel have taken material form as genes, and the intensive study which has been given to these new units has yielded much exact knowledge as to their location, and even some idea of their number, size and other characteristics. It is not too much to say that the theory of the gene will play as important a part in the development of our science as did the theory of the cell. Indeed, for many the gene has supplanted the cell as *the* biological unit.

But the geneticist is now beginning to turn his attention to problems of development and encounters here the same difficulty which faces the cellular embryologist. He has learned much about the gene as it occurs in the fertilized egg, primarily through a study of gene-controlled differences in the adult organism; but how the gene is actually related to the development of these traits is still unknown. The spectacular analysis of the cell and thus of the entire organism into an aggregation of genic units has thus far proved no more helpful in solving the basic problems of development than was the earlier analysis into an aggregation of cellular units.

But perhaps the process of subdivision should be carried still further. Students of cytogenetics hopefully discuss the possibility of an analysis of the gene into even smaller units and thus of bringing their problem to the very door of the biochemist. Those who feel content only when their problems can be stated in terms of atoms and molecules look to such an analysis for a final solution, but it is permissible to wonder whether, even if the molecular constitution of every gene were known, we should not still be confronted with the problem of exactly how this elaborate series of units actually gets itself built into what we so well have named an organism.

The repeated failure of these various attempts to solve the problem of organized development by cutting up the individual into smaller and smaller unitary elements breeds the uneasy suspicion that here again, as in so many other scientific problems, we have been confusing analysis with solution. The scientific temperament feels much more comfortable when it is breaking down a complex phenomenon into simpler parts than when it is trying to pull together a series of diverse facts into a unity of relationship. For a solution of the ultimate riddles, however, synthesis is more important than analysis. It is far less easy to come by, and often requires the intuition of genius itself. Thus the progress of chemistry has been marked by an analysis of the material universe into a series of ninety-two different kinds of atoms, which arrange themselves into units of a higher order, the molecules, and are themselves further resolvable into unitary charges of electricity. This was an accomplishment of supreme importance, but Mendelejeff's recognition of orderly relationships between these elements at once made it possible to bring together a

wide range of diverse and hitherto unrelated facts into a single integrated system and thus to achieve a far deeper insight into the nature of matter. Similarly, the chief purpose of biology for a long time was to analyze the plant and animal kingdoms into a series of orders, families, genera and species, which seemed to be as arbitrarily arranged as the letters of the alphabet; but Darwin's great synthesis at once made clear that the organic world was not a series of unrelated units but was knit together in the ultimate unity of a common descent. The genius of another Darwin is needed to-day to discover how the complex of molecules, genes and cells are integrated to form a living organism. It is not an understanding of units which we now seek, but of unity. We are like the small boy who takes the clock apart to discover the secret of its running, but after he has dissected the works into an impressive array of wheels, gears and springs is unable to put them together again successfully and is still as far as ever from an understanding of synthetic horology. Like him, we need to know the principles underlying the construction and operation of our machine. Analysis is not enough.

I do not wish in any way to disparage the usefulness of the analytic method or to minimize the very great value of the discoveries which have been made by its means. An understanding of the relations which the products of an analysis bear to each other, however, is quite as essential as the analysis itself. It is important to know that a molecule of water may be resolved into two atoms of hydrogen and one of oxygen, but still more important to know what are the properties and relationships of hydrogen and oxygen which result in the production of a molecule of water when they unite. The analysis has long since been made, but an understanding of the synthesis is still beyond our powers. It is important to know that a living plant is composed of cellular units, but it is even more important to understand how, through the multiplication and interrelations of these units, the orderly development of an organism is assured. The analysis is more than a century old; the synthesis is still far from consummation.

But if the synthetic approach to problems of development is so much to be desired, why in practice has it proven relatively unfruitful? The inherent difficulties of the method and the intractability of the materials to which it is to be applied have doubtless been chiefly responsible. Many biologists have been deterred by these difficulties from attacking the problems or organization at all. Others, despairing of finding a solution through the familiar techniques of their science, have begun to explore the possibilities of ideas and postulates foreign to the familiar biological idiom. The more tender-minded among them have needed little encouragement to run after the strange gods of mysticism and metaphysics and have set up in their midst the golden calf of entelechy. Even those who remain in the ranks of the orthodox speak the unfamiliar language of holism, organicism, metabolic gradients, allometry, organizers, morphogenetic fields, gestalten and other words outlandish in the ear of analytical biology and which for the most part are merely the terminology of enlightened ignorance.

It is not strange, therefore, that many students of development have ceased to concern themselves with what seem to be the fruitless and often demoralizing problems of the synthesis, organization and integration of living things. This defeatist attitude is hard to defend. Granted that the mechanics of development may be among the most recondite of problems, we surely can not admit that it is not open to scientific approach. Granted that it lends itself to fantastic and unsupported speculation and has always attracted the lunatic fringe of our science, yet surely this should not prevent the serious student from applying to its solution the sound and tested methods of biological research. Granted that to coordinate the data of biochemistry, biophysics, cytology, morphology and genetics requires a breadth of training and catholicity of view-point almost impossible to gain to-day, yet the job must be done. My plea is for more laborers in this vineyard. Difficult the task surely is, but by no means hopeless. It should be our chief ultimate concern, for the very autonomy of biology rests upon the phenomenon of organization. Whatever distinguishes the life sciences from the physical sciences lies here, and here we must ultimately succeed or surrender our birthright.

But how can we lay hold of such an elusive and difficult problem? The failure of the cell theory to explain development has at least shown that "Divide and conquer" is a futile strategy to follow in this particular campaign. The easy philosophy that the ultimate task is simply to resolve an organism into its constituent genic or chemical elements and that all else will follow is clearly not enough. Biology is more than biochemistry. Something more profound is required. We must discover the relationships between developmental units and thus the manner in which organized syntheses arise. This task may well be too much for biology alone, and we must nourish no false pride which would disdain the help of any branch of knowledge. The chemist, with his hormones, organizers and other morphogenetic substances, must certainly be our constant companion. The physicist should more often be consulted, especially when he can speak with certainty of polarity, gradients, potential differences and fields of force in an organism. The mathematician, with his curves and coordinates, his beautifully precise methods

of describing relationships and his remarkable science of topology, is evidently a friend to be closely cultivated. Since the climax of the integrative process seems to be the development of conscious personality, the student of organization should not fail to examine the findings of the psychologist, inexact and subjective as these often appear to an outsider; for, after all, the most intimate knowledge we can ever possess of any living organism is yielded through our unique point of vantage within one of them. Our problem may reach out so far that it transcends the more familiar categories of scientific thought so that ultimately we can not shirk the necessity of facing the problems of biological philosophy, and here the professional philosopher, especially if he has the advantage of understanding the results of modern biology, will be an indispensable guide. These all must be our allies. Let us never grow so pedantic that we shall frown on any brother who occasionally goes off the reservation of biological orthodoxy to refresh himself in other fields. He may well bring back from his excursion a treasure which those who stay at home can never find.

To all this, I am sure that most of you will readily agree; but you will point out that for years many of the best minds in biology have been devoted to just this problem; that the literature of Entwicklungsmechanik is enormous; that I am offering but a counsel of perfection in a field the difficulties of which I seriously underestimate, and that unless I have some constructive suggestions to offer, this would be a very appropriate time for me to sit down. I admit the validity of much of this indictment and hasten to offer here my own very slender contribution toward the solution of our problem. It is a development of two simple ideas, namely, that the process of biological organization takes place at various essentially independent levels and may be studied at any of them, and that one of these levels, the development of the multiple, determinate organ of the higher plants, provides exceptionally favorable material for such a study. These suggestions I propose to discuss briefly here.

Following the lead of the zoologists, we have been accustomed to look for developmental relations between the cell and the body as a whole. In plants, with their much looser organization, the problem is simpler than this, for there is clearly a level of organization between cell and body, the multiple organ, repeated indefinitely in a single individual and bearing somewhat the same unitary relation to the body as a whole that the cell bears to it. The nodes and internodes, leaves, flowers and fruits of the higher plants are examples of this sort of unit. The fruit, for various reasons, is especially favorable for study, and it is evidence from fruit development in the family Cucurbitaceae which I wish first to present.

That the fruit here is a distinct developmental entity, essentially independent of the cell below it and of the entire body above, is indicated by a number of facts. In any given race, the fruit has a very definite developmental history, both as to its size and form and as to its internal differentiation. This history is altered little or not at all by the size or character of growth of the plant as a whole. Environmental factors which markedly influence plant size have little or no effect on fruit size unless they are extremely unfavorable. Conditions which greatly increase total growth of the plant will increase the number of fruits it bears but not their size. The plant body is an indeterminate series of such multiple structures, their number depending on environmental factors but their particular characteristics being essentially autonomous.

Evidence is now available that the organ is equally independent of the next lower unit, the cell. If the growth of a cucurbit fruit from a tiny ovary primordium until several days after fertilization is measured, the rate of increase is found to be constant, there being a uniform daily percentage increment which is characteristic for a given race. Investigation shows that cell multiplication is occurring abundantly during the early part of this exponential growth period but then ceases, and that all subsequent growth results from cell expansion. The rate of growth, however, is exactly the same whether the cells are dividing or not. Furthermore, even while cell division is still going on, cell size is slowly increasing and the rate of division slowly decreasing. Thus the mass of material being poured into the young fruit is growing at a constant rate regardless of whether this mass is being cut up into new cells rapidly, slowly or not at all. Dry weight follows the same procedure, for it increases at a constant rate both before and after cell division ceases. Differentiation, too, proceeds independently of cell division, for the rate of division is found to be the same in all regions (axis, inner, middle and outer wall, and epidermis) but the relative proportions of these various regions change markedly along a gradient from the inside of the fruit outward. This evidence all suggests that the mechanisms controlling growth and differentiation in the fruit are concerned with the entire organ and not with the behavior and interrelationships of the individual cells of which it is composed. The unity of behavior, and thus presumably the unity of organization, inheres in the whole and not in its elements.

On its own level the cell also displays a unity of organization independent of the organ above or of smaller units below. Biologists have long recognized that cell size, for a given tissue, is relatively constant as compared with organ and body size. Every cell also seems to possess a uniform complement of genes.

These are not arranged at random but in a very definite order in each chromosome, and this constancy of position seems important in determining the rôle which a gene plays in development. Nor are the chromosomes entirely independent, for events in one have been shown to have effects on the others. The essential elements in the cell seem clearly to be the genes, for it is known that if one or at most a few of these are lacking, the cell will die. So far as can be determined the genes are of the same general order of magnitude and seem to be fundamentally similar units. It is in accord with the facts to regard the cell as an organized group of equivalent but somewhat differentiated genic units, just as we regard the organ as an organized group of equivalent but somewhat differentiated cells.

Of course one can speculate on the possibility that the gene itself is an organized aggregation, at a lower level, of still smaller units, perhaps protein molecules or simpler chemical entities, but our knowledge of genic constitution can go no further than to suggest that such may be the case. What is the ultimate living unit, if there is one, and of what it is composed are questions for the future to answer.

It should be noted that this process of organization is not a mere building up of similar units into an amorphous mass. Their arrangement and interrelations produce specific patterns which are evidently the result of a control more precise than one which would merely bring them together. Hence arises the problem of the development of organic form, which makes dynamic morphology a fundamental biological discipline.

The problem of organization thus presents itself as one which is concerned not with the entire organism alone but with a hierarchy of successively more advanced and essentially independent levels, from the gene or a still smaller unit to the body as a whole. It can be studied profitably at any level, for evidently the same process is at work in all of them, namely, the integration of a group of essentially similar units into a unity of a different and higher order with a specific pattern of its own. The primitive units of life, whatever they were—possibly something akin to genes or to virus particles—may have become organized into the systems which we now recognize as cells. Groups of cells remaining together in a multicellular mass may then have organized themselves into some higher entity, such as the metamere in animals or the multiple organ or perhaps the "phyton" in plants. From a series of these units is built up, in turn, the most complex entity of all, the body of the individual organism. In plants and many lower animals, like the annelids, this is still rather loosely organized and consists of an indeterminate number of essentially similar units. In most animals, however, integration is much more complete and the body has become a closely knit and highly differentiated entity. Throughout all these levels, the process is thus the same. So long as a mass of living material is continuous there is manifest in it this persistent urge to pull all parts together into a unity. Protoplasm seems inherently integrative in its activity, and only in certain tissue cultures and in clearly pathological conditions does this propensity for organization disappear. From this point of view, then, the cell is to be regarded not as a unique unit, but simply as one member of a series of units.

A recognition of the fact that organization is not a single event but proceeds from level to level is but a short step forward on a long and difficult path. How these units are pulled together and molded into a higher patterned synthesis is still beyond our knowledge. At least it is encouraging to know that the problem may be attacked at any level along the series and that we therefore possess the advantage so much esteemed by good generalship of being able to choose our battle-ground. The cell is too small for easy investigation, the whole body too complex. The multiple organs of the higher plants, however, offer ideal material for such studies. Of these organs the fruit is particularly favorable. It is large enough for easy investigation. Its form is relatively simple. It rarely becomes highly differentiated. Its structure is not closely involved with the function which it performs, as is that of the leaf. It has a relatively long developmental history. It is available in large numbers in the same individual, so that genetic identity is assured even under very diverse conditions. Developmental studies of such organs should yield much information as to the facts of growth and organization and should prove even more significant than have the more familiar studies on the early animal embryo. These structures, it seems to me, offer to botanists a notable opportunity for productive work on the problems of development.

In conclusion you will doubtless expect at least a word of concrete suggestion as to procedure. How can we lay hold of the elusive problem of organization, even with the best of material? The advice I have to offer will seem prosaic enough. It is to begin by describing with the utmost detail the phenomenon of organized development. Before the Darwin of morphogenesis can profitably indulge in synthesis, coordination and generalization, he must be provided with a far greater body of facts than are now available as to what actually happens in all stages of the developmental process. Our immediate task is to state as fully and exactly as possible, in terms of number, size, rate and position, just what occurs when an organized whole builds itself by multiplication of its parts. A vast amount of spade work of this careful but uninspiring sort must be done, tedious in execution but

fruitful in results, in order to provide a basis of facts sufficiently rich and varied so that among them some thoughtful student may begin to perceive those significant relationships which will finally lead him into the heart of the problem.

Those early biologists who established the cell theory made the first great contribution to such a descriptive study of development, and under the stimulus of their idea, biological analysis has gained many triumphs in the century that is past. We can best honor these pioneers of yesterday, however, not by pushing indefinitely onward over the path they first began to blaze and which now seems destined to end blindly in discouragement and frustration, but rather to follow the pioneers of to-day along the far more difficult path which will lead, however distantly, to an understanding of biological syntheses. Life is integration. Life is the knitting together of units into patterned wholes. Many of the units we know, thanks to the labors of a hundred years. An understanding of how these units are built into the fabric of an organism is the task for the hundred years that are to come.

MATHEMATICIANS, AND POETRY AND DRAMA. II*

By Professor RAYMOND CLARE ARCHIBALD
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I have referred to Hamilton as a youthful prodigy able successfully to compete with the American mental calculator, Zerah Colburn. But among many gifted mental calculators who gave public exhibitions of their prowess, no one could compare with Zacharias Dase, who was born at Hamburg in 1824 and died in 1861. He is known to have extracted the square root of a 100-figure number in 52 minutes, and to have multiplied two 100-figure numbers in $8\frac{3}{4}$ hours; there is reason to believe that this last-mentioned multiplication was no great tax upon his powers of mental arithmetic. Gauss, the greatest living mathematician of his time, got him to work on calculating mathematical tables of value, and as a result four important volumes were published. A few years before his death Dase published a volume of material about himself, extracted from his scrapbook.[53] In this material are 69 stanzas or poems in a variety of forms and by as many different authors. So far as I am aware this is the largest number of so-called poems on any single mathematician. But these measure rather the popular appeal of his peculiar gift.

No such acclaim awaited two men of superlative genius who died in their twenties about the time that Dase was born, but whose names are constantly mentioned wherever mathematical research is now carried on. The one was Evariste Galois, a Frenchman, killed in a duel when 21 years of age. The other, probably the greater genius, was Niels Henrik Abel[54] (1802-29), of whom Norway was later so proud. After the articulation of far-reaching mathematical discoveries and a gallant struggle with poverty, he died of tuberculosis at the age of 27, just as his achievements had brought high recognition, which would have filled his later life with ease and content and given him untrammeled opportunity to draw back curtains hiding eternal truths. At the centenary of his birth in 1902 a great international celebration was held in Oslo,[55] and a long French poem on "Abel" was read by Bjørnstjerne Bjørnson.[56] Happy indeed was the expression of thought in two lines of this poem:—

> Là où il a été
> on ne pense plus sans lui.

Several other poems about him include one engraved on his tomb. The centenary of Abel's death was internationally celebrated in 1929, and four Norwegian postage stamps bearing his portrait were then issued.[57]

Let us turn now to a British centenary. Nearly seven years ago throughout the English-speaking world there were elaborate celebrations of the centenary of the birth of Charles Lutwidge Dodgson[58] (1832–1898), familiarly known by the pen name Lewis Carroll, which he first used in connection with a poem he published shortly after he graduated from Oxford. No other mathematician in the writing of nonsense produced such an effect on his country's literature[59] or became

* Concluded from the issue of SCIENCE for January 13.

53 "Zacharias Dase. Aufschlüsse und Proben seiner Leistungen als Rechenkünstler. Mitgetheilt von ihm selbst aus seinem Album," Berlin, 1856, vi + 122 pp.

54 G. Mittag-Leffler, *Revue du Mois*, 4: 5–26, 207–229, 1907; E. T. Bell, "Men of Mathematics," New York, 1937, pp. 307–326; G. Prasad, "Some Great Mathematicians of the Nineteenth Century," Benares, v. 1, 1933, pp. 111–165.

55 "Niels Henrik Abel. Memorial publié à l'Occasion du Centenaire de sa Naissance," Christiania, 1902.

56 See footnote 54.

57 *Scripta Mathematica*, 1: 183, 1932.

58 E. V. Lucas, "Dict. Nat. Biog," Suppl., v. 2, 1901. W. De La Mare, "Lewis Carroll," London, 1932; the best appreciation of Alice and her creator. S. H. Williams and F. Madan, "A Handbook of the Literature of the Rev. C. L. Dodgson (Lewis Carroll)," and Supplement, Oxford, 1931, 1935; invaluable work. F. Madan, ed., "The Lewis Carroll Centenary in London, 1932, including a Catalogue of the Exhibition, with Notes," London, 1932. *Scripta Mathematica*, 1: 172–175, 349, 1932; 4: 318, 1936. "Catalogue of an Exhibition at Columbia University to Commemorate the One Hundredth Anniversary of the Birth of Lewis Carroll," New York, 1932.

59 F. J. H. Darton, "Children's Books in England," Cambridge, England, 1932, pp. 263–269.

so universally popular. His writings have been translated into Braille, Chinese, Czech, Danish, Dutch, Esperanto, French, German, Hebrew, Hungarian, Irish, Italian, Japanese, Latin, Norwegian, Polish, Portuguese, Russian, shorthand, Spanish and Swedish.

Dodgson was a mathematical lecturer at Oxford for more than twenty-five years, 1855-81, and he was ordained a deacon in 1861. Some of his more substantial mathematical publications are the following: "Syllabus of Plane Algebraical Geometry (1860); "Elementary Treatise on Determinants" (1867); "Euclid and his Modern Rivals" (1879; second ed. and *Supplement,* 1885), in dramatic form; "Curiosa Mathematica" (2 v., 1888–93, 4 eds.) of which the second volume was entitled "Pillow Problems thought out during Sleepless Nights"; "Symbolic Logic, Part I, Elementary" (1896, 4 eds.).

In 1933 his verse was collected in a volume of over four hundred pages. Most of the poems and songs are taken from such works as "Alice's Adventures in Wonderland," "Puzzles from Wonderland," "Through a Looking Glass," "Phantasmagoria," "The Hunting of the Snark," and "Sylvie and Bruno." Many of the songs have been set to music, and accompanying music has been written for a number of Lewis Carroll's writings which have been dramatized; more than sixty items might be mentioned in this connection.[60] There are also scores of parodies of Carroll's writings by others.[61] Much of the effect of many of his own poems was due to the fact that they were such admirable parodies of well-known poems of, for example, Hood, Longfellow, Scott, Southey, Swinburne, Tennyson, Watts and Wordsworth.

Poems about Carroll are doubtless fairly numerous. Among them are *Punch's* tribute by Owen Seaman,[62] and those by Austin Dobson,[63] E. V. Lucas[64] and Margaret Sangster.[65]

As Oxford and Cambridge are closely associated in our thought, it is but natural that next we should consider a Cambridge man. Not long ago a query was raised in the London *Times*[66] as to the authorship of a stanza

> No power on earth, however great,
> Can pull a string, however fine,
> Into a horizontal line
> That shall be absolutely straight.

A correspondent pointed out that it was to be found in the first edition (1819) of "An Elementary Treatise on Mechanics" by the prodigiously learned William Whewell[67] (1794–1866), who was second wrangler in 1816, master of Trinity, author of 'The History of Inductive Sciences," of "The Plurality of Worlds" and of many mathematical works. In the chapter on "The Equilibrium of Forces on a Point" the following "accidental stanza" occurred in the sentence: "Hence no force however great can stretch a cord however fine into an horizontal line which is accurately straight." In the form first quoted the original meter has been repaired. "Accurately" has been crowded out by a stronger word. It must have been the wags of Trinity College, Cambridge, who adorned the Whewellian muse. The matter was the subject of an editorial in the *New York Times.*[68]

But Whewell was the author of many real poems. One of the principal honors which he gained in his undergraduate career was the chancellor's medal for the best poem on Boadicea. When about 50 years of age he published a translation of Goethe's "Hermann und Dorothea," and various original poems in *Blackwood's Magazine.* But two volumes of his verse appeared in 1847, the first entitled, "Verse Translation from the German: Including Bürger's Lenore, Schiller's Song of the Bell and Other Poems"; and the second, "Sunday Thoughts and Other Verses." Eight years later, shortly after the death of his first wife, Whewell circulated some privately printed "Elegiacs," consisting of about 800 lines in 13 sections. In thanking Whewell for a copy, the poet Longfellow wrote: "I have read the poems with great interest and pleasure; and yet a painful sympathy with you in your affliction, which has found expression in such musical numbers. I am delighted to see the Elegiac metre introduced into English verse; it is so beautiful, and satisfies the ear so completely. And to you we must give the honor of its introduction, if we pass over the few specimens of translation from the German." When Whewell later wrote a review praising Long-

[60] See Williams and Madan, *loc. cit.,* pp. 263–281; Supplement, pp. 18–20.

[61] See, for example, W. Hamilton, "Parodies of the works of English and American Authors," London, v. 4, 1887, pp. 55–59; C. Wells, "A Parody Anthology," New York, 1918, pp. 264–267; W. Jerrold and R. M. Leonard, "A Century of Parody and Imitation," Oxford, 1913, pp. 358–360; also, Williams and Madan, *loc. cit.,* pp. 287–309.

[62] Jan. 29, 1898; see Williams and Madan, *loc. cit.,* p. 246.

[63] Prefacing "Alice's Adventures in Wonderland," illustrated by A. Rackham, London, 1907; often reprinted.

[64] E. V. Lucas, "Another Book of Verses for Children," New York, 1925, pp. 377–378.

[65] *Good Housekeeping,* 94: 23, 1932.

[66] March 25, 1935.

[67] Leslie Stephen, "Dict. Nat. Biog.," v. 60, 1899. I. Todhunter, "William Whewell, D.D., Master of Trinity College, Cambridge," 2 v., London, 1876; "English Hexameters," pp. 283–301, "Poetical Pieces," pp. 367–375, 167. Mrs. S. Douglas, "The Life and Selections from the Correspondence of William Whewell," second ed., London, 1882, see especially pp. 87–88, 115–119, 243–244, 537–586. A. Macfarlane, "Lectures on Ten British Physicists of the Nineteenth Century," New York, 1919; "William Whewell," pp. 84–93.

[68] April 19, 1935; see also R. C. Archibald, *idem.,* April 23, 1935.

fellow's use of English hexameters in his "Evangeline," Longfellow was greatly pleased.

Whewell is also credited with the following verses:

U O a O, but I O thee,
O O no O, but O O me;
Then let not my O a O go,
But give O O I O thee so.

which is to be interpreted as:

You sigh for a cypher, but I sigh for thee,
O sigh for no cypher, but O sigh for me;
Then let not my sigh for a cypher go,
But give sigh for sigh, for I sigh for thee so.

One can imagine Wallie Hurwitz and Caesar Davis[69] exclaiming, *Whew—well* done!

The great variety of Whewell's studies struck some of his contemporaries as peculiar; for instance, Sidney Smith said of him: "That man's forte is science, and foible omniscience."

But almost a century before this Master of Trinity was appointed to a professorship at Cambridge, there died one who had been also a student and professor at Trinity, the greatest mathematical genius who has ever lived.

Newton died in March, 1727, and in June the future nature poet James Thomson (1700–1748) published his 209-line poem "Sacred to the memory of Sir Isaac Newton." It was issued as a folio volume dedicated to Sir Robert Walpole, then prime minister of Great Britain; four other editions were called for in the same year,[70] and two editions of an Italian translation were published in 1741 and 1760.[71]

Alexander Pope had a gift for the composition of epitaphs and often wrote them, or was called upon to revise those already written. His epitaph intended for Newton's tomb in Westminster Abbey, five lines in Latin and two in English, may be quoted[72] in this connection:

Isaac Newtonus:
Quem Immortalem
Testantur *Tempus, Natura, Coelum:*
Mortalem
Hoc marmor fatetur.
Nature and Nature's Laws lay hid in night:
God said, *Let Newton be!* and all was light.

This last fine epigram is often quoted. I was recently much surprised to discover that Aaron Hill, a contemporary of Pope, had not only written a poetic epitaph on Newton, but also the following epigram:

O'er nature's laws, God cast the veil of night,
Out blaz'd a Newton's *soul*—and *all* was *light.*

[69] That is, H. T. Davis, author of "The Fine Art of Punning" . . ., Colorado Springs, 1916.

[70] London, 3 eds., and Dublin, 1 ed.

[71] "Il Riccio Rapito [A. Pope] e le Lodi di Neuton [J. Thomson]. Poemi inglesi tradotti in Versi toscani dal Sig. A. Bonducci . . . con altri nuovi componimenti," Naples, 1760.

[72] "The Works of Alexander Pope." New ed. by Elwin and Courthope, London, v. 4, 1882, p. 390.

The great similarity of these lines to Pope's couplet suggests at once the question, Were they published before Pope's was in *The Grub Street Journal* for July 16, 1730? I found them in the first edition of Hill's "Works" published in 1753, four years after Hill, and nine years after Pope, had died. Hill's abilities as a poet and his relations to Pope hardly suggest that Pope was in any wise indebted to Hill.

As yet I have made no systematic effort to assemble *all* poems written about Newton[73] at the time of his death. The only other one with which I have met was that of another contemporary of Pope's, namely, Allan Ramsay (1685–1758), whose 14-verse "Ode on Sir Isaac Newton. Inscribed to the Royal Society of London for improving Natural Knowledge," recalls the fact that at the time of his death Newton had for 24 consecutive years been president of the Royal Society.

In more recent times we remember the "Watchers of the Sky" (1922) of Alfred Noyes, the first of his 3-volume work on "The Torch-Bearers." The fine forty-five page section on "Newton," not always conforming to the latest results of historical research, begins thus:

"If I saw farther, 'twas because I stood
On giant shoulders" wrote the king of thought,
Too proud of his great line to slight the toils
Of his forebears. He turned to their dim past
Their fading victories and their fond defeats,
And knelt as at an altar, drawing all
Their strengths into his own; and so went forth
With all their glory shining in his face;
To win new victories for the age to come.

And the concluding lines:

He rose at last so near
The Power divine that none can nearer go;
None in this age! To carry on his fire
We must await a mightier age to come.

It would seem as if Noyes must here have had in mind the closing lines of Edmond Halley's fine Latin ode on Newton prefixed to the first edition of Newton's "Principia.[74] In the translation of Professor Richardson, of the University of California, the concluding lines are as follows:

Then ye who now on heavenly nectar fare,
Come celebrate with me in song the name

[73] J. W. N. Sullivan, "Isaac Newton, 1642–1727," London, 1938. E. T. Bell, "Men of Mathematics," New York, 1937, p. 90–116. L. T. More, "Isaac Newton, a Biography," New York, 1934. "David Gregory, Isaac Newton and their Circle," ed. by W. G. Hiscock, Oxford, 1937, "Sir Isaac Newton 1727–1927. A Bicentary Evaluation of His Work. A series of Papers prepared under the auspices of the History of Science Society," Baltimore, 1928. Mathematical Assoc., "Isaac Newton 1642–1727. A memorial Volume," London, 1927. *Scripta Mathematica,* 1: 179, 271; 2: 290–291; 3: 85, 185–186, 272; 4: 180–181. 1932–1936.

[74] Halley's Latin hexameters were printed in unmutilated form in only the first edition of Newton's "Prin-

Of Newton, to the Muses dear; for he
Unlocked the hidden treasuries of Truth;
So richly through his mind had Phoebus cast
The radiance of his own divinity.
Nearer the gods no mortal may approach.

It is this last line, "Nearer the gods no mortal may approach" which may be compared with that of Noyes:

He rose at last so near
The Power divine that none can nearer go.

There are many incidental references to Newton in the poets; I shall refer to only a few among English poets. Four are to be found in poems of Byron—one in his "Poem on Churchill's Grave" and three in stanzas of "Don Juan." The first stanza of canto X of the latter is as follows:

When Newton saw an apple fall, he found
In that slight startle from his contemplation—
'Tis *said* (for I'll not answer above ground
For any sage's creed or calculation)—
A mode of proving that the earth turned round
In a most natural whirl, called "gravitation";
And this is the sole mortal who could grapple
Since Adam—with a fall—or with an apple.

Towards the end of his life Newton is reported to have remarked: "I do not know what I may appear to the world; but to myself I seem to have been only like a boy, playing on the seashore, and diverting myself, in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me." This will explain the allusion in stanza 5 of canto VII of Don Juan:

Newton (that proverb of the mind), alas!
Declared, with all his grand discoveries recent,
That he himself felt only like a youth
Picking up shells by the great ocean—Truth.

One of Newton's great discoveries was that by means of a prism he could break up white light into its component colors. This prism is noted in Wordsworth's reference in the "Prelude," to Roubilliac's statue of Newton, the finest of all the statues in the chapel of Trinity College, Cambridge:

And from my pillow, looking forth by light
Of moon or favoring stars, I could behold
The ante chapel where the statue stood
Of Newton with his prism, and silent face,
The marble index of a mind for ever
Voyaging through seas of Thought, alone.

And finally, we may recall the passage in Southey's "Translation of a Greek Ode on Astronomy,"

There Priest of Nature! dost thou shine,
Newton! a King among the Kings divine.

Another great mathematical genius at Trinity College, who afterwards became a professor in the university, was James Clerk Maxwell[75] (1831–1879), whose work has had a profound influence on the progress and conceptions of physical science. It has, moreover, been instrumental in harnessing the ether for service of man and has thereby advanced civilization and increased the safety and happiness of mankind. He was another of the famous second wranglers, and wrote many papers of great value in the fields of pure and applied mathematics. It was early in his school career that he began to write verses, a practice which he kept up all his life, to the great delight of his friends. Many of these, including one famous in the domestic history of Trinity College, an ode "To the committee of the Cayley portrait fund" (1874), are given in Campbell's "Life" of Maxwell.[76]

We have referred to Whewell and Maxwell as second wranglers at Cambridge. Another who started his mathematical career as second wrangler, in 1837, became one of the most interesting and eminent of British mathematicians of the nineteenth century, James Joseph Sylvester,[77] who was born in 1814 and died in

cipia," London, 1687. In the second edition (1713) Bentley omitted lines and touched up the Latinity in a number of places—not to its improvement, according to some scholars (*e.g.*, R. A. Sampson, *Nature*, 135: 129, 1935). In the third edition of the "Principia" Pemberton made but slight changes in Halley's original version. This is also to be found in "Selecta Poemata Anglorum Latina," Bath, 1776, v. 3, p. 29. The three "Principia" versions were reprinted in: (a) S. P. Rigaud, "Historical Essay on the First Publication of Newton's Principia," Oxford, 1838, p. 85–87; (b) D. Brewster, "Memoirs of the Life, Writings and Discoveries of Sir Isaac Newton," Edinburgh, v. 1, 1855, pp. 457–459; (c) C. F. MacPike, "Correspondence and Papers of Edmond Halley," Oxford, 1932, pp. 203–206. On pp. 207–208 of MacPike's work Halley's ode is given in English translation, by "Eugeno," which Rigaud states, "is not well done" and which was originally published in Benjamin Martin's *General Magazine of Arts and Sciences, Miscellaneous Correspondence in Prose and Verse* for January, 1755, London, v. 1, 1759, p. 4. This was also reprinted in *Popular Astronomy*, 12: 504–506, 571, 1904. A new translation by L. J. Richardson is given in the Motte-Cajori edition of Newton's "Principia," Berkeley, Calif., 1934; Sampson, *loc. cit.*, characterizes this as "a poor affair and gives no evidence that the writer knew what he was talking about." The translation into Ido by G. H. Richardson, of Newcastle-upon-Tyne, England, was first published in *Kulturo, revuo por l'internaciona Kulturo per l'internaciona Linguo*, Budapest, 2: 29–31, January-February, 1924; reprinted in *Biblioteko dil Internaciona Kulturo*, 9, Budapest, 1924, and in G. H. Richardson, "Spaco e Tempo," Newcastle-on-Tyne, 1929. It was also reprinted, with the Latin of 1687, in Richardson's "Laudo di Newton da Halley," Newcastle-on-Tyne, 1925.

[75] For the general reader the following little volume would be especially interesting: "James Clerk Maxwell. A commemoration Volume 1831–1931. Essays" by J. J. Thompson, M. Planck, A. Einstein, J. Larmor, J. Jeans, W. Garnett, A. Fleming, O. Lodge, R. T. Glazebrook and H. Lamb, Cambridge, 1931. A. Macfarlane, "Lectures on Ten British Physicists of the Nineteenth Century," New York, 1919, pp. 7–21.

[76] L. Campbell and W. Garnett, "The Life of James Clerk Maxwell," London, 1882, pp. 577–651.

[77] A. Macfarlane, "Lectures on Ten British Mathematicians of the Nineteenth Century," New York, 1916, pp.

1897. The father's name was Abraham Joseph, but his five sons—the eldest settled in New York—adopted the name Sylvester. James, the mathematician, was the youngest, and he has more than one connection with America; he was professor at the University of Virginia[78] in 1841–42 and the first professor of mathematics at the Johns Hopkins University from 1876 till 1883, when he was appointed Savilian professor of geometry at Oxford. Before the Johns Hopkins University opened its doors to students, the trustees of the institution were discussing with its president, Daniel Coit Gilman, the question of how to begin the work of the university which was to be a potent factor in higher learning in America. "Enlist a great mathematician and a distinguished Grecian," said the president, "your problem will be solved. Such men can teach in a dwelling house as well as in a palace . . . Other teachers will follow them." And thus were appointed the great Gildersleeve and the "soaring-geniused Sylvester," as Sidney Lanier characterized him.[79] Sylvester was the first editor, at Baltimore, of a great mathematical research journal, and he may be thought of as an inspiring source of modern American mathematics.

Throughout his life he gave evidence of thought teeming with poetical fancies. He had a keen relish for striking phrases, and many of his mathematical papers not only have original poetical introductions but are interspersed with poetical passages. Six years before coming to Baltimore he published a volume entitled "The Laws of Verse, or Principles of Versification Exemplified in Material Translations," and dedicated to his friend Matthew Arnold. The work contains many excellent translations from Horace and from German authors, as well as some original poems. He was accustomed to express his feelings in sonnets, and in his last years he composed considerable Latin verse. He wrote several "Studies in Monochrome," so called because they rang the changes upon a single rhyme through a long series of verses. Sylvester thought that these performances had an effect like that of "the regularly recurring dash and plash of the waves on the seashore." One such poem was "Rosalind," a "mock-sentimental" poem of four hundred lines, all ending in ĭnd or īnd. On several occasions Sylvester gave public readings from his poems. Lanier has given us an account of one performance at the Peabody Institute, Baltimore, in 1879 when his poem "Rosalind" was to be read.

> The audience quite filled the hall and expected to find much interest or amusement in listening to this unique experiment in verse. But Professor Sylvester had found it necessary to write a large number of explanatory footnotes, and he announced that in order not to interrupt the poem he would read the footnotes in a body first. Nearly every footnote suggested some additional extempore remark, and the reader was so interested in each one that he was not in the least aware of the flight of time or of the amusement of the audience. When he had dispatched the last of the notes, he looked at the clock, and was horrified to find that he had kept the audience an hour and a half before beginning to read the poem they had come to hear. The astonishment on his face was answered by a burst of goodhumored laughter from the audience, and then, after begging all his hearers to feel at perfect liberty to leave if they had engagements, he read the Rosalind poem.[80]

Since we have returned to America the voyage of observations draws to a close. Among those visited, who have been outstanding in poetry and drama? In this regard international acclaim has surely set on high the following men of mathematics: Omar Khayyám, Echegaray and Lewis Carroll, and the publications of Lewis Carroll, of which the poetry forms an important part, have been found to be the most universally popular. With reference to the mathematics of their times, Omar Khayyám was the leading mathematician of this trio.

What may be said concerning the literary productions of such geniuses and the future? In the case of Carroll the late E. V. Lucas, rare charmer of both children and adults, has made reply:

> "But will," the Prillil girl inquired,
> "His writings ever die?
> Will people always love his books
> The same as you and I?"
> "There is no doubt at all of that,"
> The Grownup made reply.

107–121. E. T. Bell, "Men of Mathematics," New York, 1937, pp. 378–405. R. C. Archibald, "Unpublished letters of James Joseph Sylvester and other new information concerning his life and work," *Osiris*, 1: 85–154, 1936; "Sylvester's poetry," p. 102–112, containing a pretty complete bibliography.

[78] A portrait painted by G. Patten in 1841, just before Sylvester left England, was thrown on the screen during the lecture, and was thus made public for the first time.

[79] S. Lanier, "Ode to The Johns Hopkins University," read 22 February 1880, *Johns Hopkins University Circular*, 1: 38, April, 1880; also in "Poems of Sidney Lanier," edited by his wife, new edition, New York, 1922, p. 108. Lines 10–14 are as follows:

> From far the sages saw, from far they came
> And ministered to her,
> Led by the soaring-genius'd Sylvester
> That, earlier, loosed the knot great Newton tied,
> And flung the door of Fame's locked temple wide.

[80] This poem began as follows:

> In Cecilia's name I find
> (Deem not thou the guess unkind)—
> Celia, with a sigh combined,*
> Whose five letters, loose aligned,
> Magic, set and recombined,
> Fairest O! of lily kind,
> Shall disclose to every mind,
> From Far West to Orient Ind
> With each mortal thing unkinned
> Thy sweet name, dear Rosalind!
>
> * Celia + ci = Cecilia.

OBITUARY

EDWARD MURRAY EAST

PERHAPS it is merely trite to say that the announcement of the sudden death of Dr. East came as a severe shock to all who knew him well. But how else can it be said? The abrupt cessation of a brilliant career—at an age which those of us, who in years were his seniors, must believe is little more than the prime of life—the sudden ending of such a career could not affect us other than with strong emotion. And yet who among us can say that East has not lived more in less than three score years than we may, if spared so long, in four score?

Edward Murray East, who died on November 9, 1938, was born on November 4, 1879, at DuQuoin, Ill., son of William Harvey and Sarah Granger (Woodruff) East. His preparatory schooling was at the DuQuoin high school. He was a student at the Case School of Applied Science in Cleveland in 1897–98 and at the University of Illinois in 1898–1905, where he received the degrees of B.S. in chemistry in 1900, M.S. in 1904 and Ph.D. in 1907. He was given the degree of LL.D. by Kenyon College in 1926.

He was married on September 2, 1903, to Mary Lawrence Boggs, of Washington, D. C., and had three children, Elizabeth Woodruff, Margaret Lawrence and Edward Murray (deceased).

He was assistant chemist, 1900–03, and first assistant in plant breeding from 1903 to 1905, at the University of Illinois Agricultural Experiment Station; agronomist at the Connecticut Agricultural Experiment Station from 1905 to 1909; assistant professor of experimental plant morphology from 1909 to 1914, and professor since 1914 at Harvard University. He was collaborator in tobacco investigations of the United States Department of Agriculture from 1908 to 1918; chairman of the botanical raw products committee and member of the botany and agriculture committee of the National Research Council in 1917–18; acting chief of the statistics division of the United States Food Administration in 1918. He was a member of the editorial board of *Genetics* since the beginning of that journal in 1916 and of the board of *Botanical Abstracts* from 1918 to 1922. He held the Harvard lectureship at Yale in 1924–25. He arranged the program of the Sixth International Congress of Genetics, held in Ithaca, N. Y., in 1932, and the success of this congress was due in no small measure to his efforts.

East was a member of numerous scientific societies: American Philosophical Society, American Society of Naturalists, of which he was president in 1918, American Genetic Association, National Academy of Sciences, New England Botanical Club, and others, and fellow of the American Academy of Arts and Sciences and of the American Association for the Advancement of Science.

A bibliography of East's scientific writings includes several books and over one hundred papers. Most of these papers present the results of his own researches in the field of genetics and its applications to plant breeding. His earliest papers, 1903–13, dealt in the main with the genetics and breeding of corn and potatoes. It was during this period that he rendered noteworthy service in the development of the method of corn breeding, crossing of inbred strains, which has revolutionized corn breeding throughout this country, a thoroughly worth-while practical method derived from theoretical genetic studies. During the latter part of this period, 1910–13, he more than any other geneticist showed the possibility of interpreting quantitative inheritance in Mendelian terms.

From about 1912 to 1929, numerous papers appeared on Nicotiana and particularly on self- and cross-sterility as exemplified in this genus. Although some, perhaps much, of this work was done by his students, his insight into this intricate problem was a guide throughout. The results of these combined and focused efforts will long stand as one of the brilliant genetic achievements of the period.

From about 1920 to the end, without abandoning his researches with plants, East turned to problems of more general interest. It was during this period that, undoubtedly as a result of judgment ripened through years of research and of wide reading, he turned more to the relations of genetics and of biology in general to human affairs. Even if, perchance, as some economists and sociologists have hinted, his economics was not wholly orthodox, it should not be overlooked that many writers have not even realized that biology has any place in discussions of human affairs.

It is not difficult to see how East's interests came to be wider than those of many geneticists. The brief outline of his student and professional career given above explains this at least in part. His early training in mathematics and physical science, particularly chemistry, progressing through agronomy and plant breeding to theoretical genetics and ultimately to more general biological problems, laid the foundation. This, coupled with wide reading, accurate observation, clear thinking and unusual clarity of expression, could not fail to give him a prominent place in the scientific developments of his generation.

R. A. EMERSON

SCIENTIFIC EVENTS

THE ACADEMY OF SCIENCES OF THE SOVIET UNION

A WIRELESS to *The New York Times* by Harold Denny, Moscow correspondent, states that preparations for the elections to the enlarged and "popularized" Academy of Sciences will take place at the end of January. It is said that there is every indication that membership will depend more than ever upon the candidate's practical value to Soviet economy and politics and upon his or her conformity to the Marxist ideology, as interpreted in Russia.

Mr. Denny writes in part as follows:

It is likely, indeed, that this august body, the outgrowth of the academy founded by Peter the Great and which even in the beginning barred scientists who were politically or ideologically undesirable, will now include Alexey Stakhanoff, coal miner credited with initiating the speed-up system that is named for him, and other new heroes of Soviet life. . . .

Stakhanoff and all four of the members of Ivan Papanin's North Pole ice floe expedition are among 800 nominees for the 150 vacancies among active and corresponding members to be elected. The Academy of Sciences now has eighty active and 230 corresponding members. By a recent decision of the government the number will be increased to 130 active and 330 corresponding members.

For several days the Soviet press has been publishing nominations, together with articles praising or blaming the aspirants. Among the nominees praised to-day in *Pravda*, Communist party organ, are Alexey Tolstoy, famous author; T. D. Lysenko, known now as the "Soviet Burbank" for his development of new species of useful plants, who has often been in conflict with classical geneticists, and Andrey Y. Vishinsky, Commissar of Justice of the Soviet Union.

Mr. Vishinsky is best known to the outside world as a prosecutor in treason cases, but he is the foremost authority on Soviet law, and his voluminous writings on that subject entitle him to consideration as a social scientist.

Other candidates advanced to-day include Evgeni Chudakoff, proposed by the Stalin Military Academy of Motorization and Mechanization of the Red Army. He is credited in *Izvestia*, government organ, with creating harmonious scientific discipline upon which automobile building and engineering are based. Another is Valentin Kovalenkoff, who is acclaimed for his researches and inventions for improving telegraphic and wireless communication.

Another is N. V. Tsitsin, one-time political commissar in the Red Guard during the civil war. He is now developing improved types of agricultural plants. According to *Pravda*, he is approved by Mr. Stalin, who told him: "Bold experimenter, we shall support you."

On the other hand, *Pravda* has lent its authoritative columns to a long article signed by ten scientists, headed by Academian A. N. Back, biologist, opposing two candidates as "pseudo-scientists" who have no place in the academy. They are Professors L. S. Berg and N. K. Koltsoff, both biologists. They are accused of promulgating views more in keeping with Fascism than Marxism.

Professor Berg, according to *Pravda*, published a book in 1922 entitled, "Monogenesis, or Evolution on the Basis of Conformity to Established Law," which evoked no praise here but was hailed by bourgeois biologists and translated into English. It is stigmatized to-day as an anti-Darwin treatise.

Professor Koltsoff is denounced as a eugenist. Eugenics as a scheme for improving the human race is, in Soviet eyes, a reactionary and imperialist teaching directed against the toilers but adopted by Fascists as a basis for racial theories.

JEWISH PHYSICIANS IN GERMANY

THE Berlin correspondent of the *Journal* of the American Medical Association states that supplementary data can now be added to the recent reports appearing on the purge of Jewish physicians. On September 24 Professor Dr. Klare, "commissioner of the specialized medical press," issued the following statement:

In view of the fact that the German medical profession is now freed of all members of an alien race, the writings of Jewish authors ought not to appear in our German medical journals. At the same time I trust that our German doctors will subscribe only to those foreign journals which are published by Aryan organizations and edited by Aryan physicians. In this connection I should like to call attention to the emigration of the journal *Ars Medici*, together with its Jewish editor and publisher, Dr. Max Ostermann, from Vienna to Switzerland. From its new home this publication continues to solicit the subscriptions of German doctors, but I feel sure that our men will refuse to have anything to do with the Jewish publisher of *Ars Medici*.

This periodical had circulated widely among practitioners within the German Reich. The correspondent continues:

With respect to Jews in the insurance panel practice, it has been newly decreed that those Jews who have been allowed to continue in medical practice (under the restrictions described in previous letters) may now take part in panel practice among insured Jews and their families; a special permit is needed for panel practice.

That, actually, a definite lack of physicians has resulted from the suppression, since October 1, of Jewish doctors is evidenced by the recent establishment of "policlinic treatment centers" at seventeen municipal clinics of Berlin. These centers are designed for the exclusive use of members of sickness insurance clubs and patients referred by the social service agencies; in other words, just those groups which are usually treated by the panel practitioners. It was expressly stated that these auxiliary centers were designed to lighten the load of the panel doc-

tors (a new consideration). The medical staffs of fourteen municipal emergency stations were also increased for the same purpose as well as for emergency house visit duty, especially at night. Meanwhile it has been decreed that the foregoing measures shall be discontinued on November 16.

When the question of obligatory practice in villages was taken up, the diet decided to take other measures to satisfy the demands for medical service and to raise the number of physicians. There are five universities with faculties of medicine, and the government proposed to establish a medical school in Lodz, a city of more than 500,000 inhabitants, which has had no university. The project was welcomed by the inhabitants of Lodz, and a committee was organized to supply financial aid for the founding of the school. The anti-Semitic organizations of students of medicine in other cities, however, passed a resolution protesting against the establishing of the school, claiming that it would increase the percentage of Jews in the medical profession, since there are many Jews in Lodz and the committee is supported financially by Jewish philanthropists. This action of the anti-Semitic students is held by democratic groups to be a handicap in the supplying of sufficient medical aid to the country. In spite of it the building of the new medical school will begin shortly.

THE COUNCIL FOR PEDIATRIC RESEARCH

THE Council for Pediatric Research is essentially a committee of the American Academy of Pediatrics, which has been in operation now for somewhat more than a year, supported for a trial period by a grant from the Carnegie Corporation. Its members are: Kenneth D. Blackfan, *chairman;* Thomas B. Cooley, *executive secretary;* Alexis F. Hartmann, Irvine McQuarrie, Oscar M. Schloss and Fritz B. Talbot. Offices are at 660 Frederick Street, Detroit.

The prime reason for the formation of the council lay in the notoriously unsatisfactory system of direct subsidization by manufacturers of investigation of their products by clinics and laboratories. Such investigations are usually prompted by a real desire to ascertain the value and uses of such products; sometimes merely for use in advertising. Studies primarily intended for advertising may, however, by proper handling give opportunity for really worth-while research. Some manufacturers are experienced enough to select competent investigators, others have wasted large amounts of money on ill-conceived, superficial, often obviously biased studies. At the best, direct subsidization is not very dignified and is open to suspicion of bias. It was believed that an impartial and authoritative committee might perform a real service by acting as intermediary between manufacturer and investigator, selecting qualified persons to carry out particular studies, suggesting or criticizing plans and finally, on publication, giving the study the stamp of its approval. It was planned that the council should charge a fee for such services, which eventually, in addition to covering its overhead, might build up a "free fund" to assist and stimulate needed research. Foundations and private philanthropists also might well dispense funds through the medium of the council.

Progress at first was slow. It was necessary to locate and gain the confidence of probable sources of grants for research, and at the same time to accumulate information as to capacities and interests of investigating clinics and laboratories. This groundwork has largely been done, and recently has shown results in the way of a number of projects which have been brought to the council for allocation to responsible clinics, and in several cases for assistance in planning a proper type of study. Another type of activity which it has recently undertaken is participation in a rather elaborate scheme for an intensive, long-term study of the various physical and mental phenomena of adolescence.

The council believes that as it becomes better known requests for its assistance will be multiplied, and its prime purpose of encouraging worth-while research furthered. It will welcome inquiries by any one interested.

THE ANNUAL REPORT OF THE SECRETARY OF THE SMITHSONIAN INSTITUTION

PROGRESS, especially in the design and construction of delicate instruments for astronomical and biological studies, and large additions to the scientific and historical collections were reported by Charles G. Abbot, secretary of the Smithsonian Institution, to the annual meeting of the Board of Regents.

The year was marked by progress in the building of the new National Gallery of Art presented to the nation by the late Andrew W. Mellon, and by the designation of a site and an appropriation for preliminary plans for a Smithsonian Gallery of Art.

Among the new instruments designed was an improvement of the galvanometer associated with the newest type of thermocouple. Dr. Abbot is confident that when the 200-inch telescope of the Carnegie Institution of Washington is available it will be possible with this instrument to get continuous spectrum energy curves of all types of stars.

A new observatory for solar radiation has been installed on Burro Mountain near Tyrone, N. M., to cooperate with the existing Smithsonian observatories in California and Chile to study solar variation and weather. Among plans for the future is one dealing with the measurement of variations of the sun's ultraviolet radiation in the upper atmosphere which can be determined by the amount of ionization of atmospheric

atoms measured with an instrument attached to a sounding balloon. The greatest variation in the sun's total radiation comes in this ultra-violet band. Knowledge of it is expected to prove of value in weather prediction.

Dr. McAlister, of the Division of Radiation and Organisms, discovered a new phenomenon of photosynthesis—an uptake of carbon dioxide by leaves in darkness. This discovery was due to the development of a new instrument for measuring carbon dioxide assimilation—a subject hitherto practically beyond the possibility of investigation.

The addition of nearly a thousand animals was made to the collections of the National Zoological Park through an expedition to the East Indies led by Dr. William M. Mann, director of the park, and financed by the National Geographic Society. The collection included numerous species never before exhibited at the park.

The Bureau of American Ethnology, the branch of the Smithsonian Institution devoted to study of the primitive peoples of the New World, made progress in untangling the complex of Indian languages, especially the extensions of the Athabascan, the tongue spoken by the red men of northwestern Canada. This has an intimate connection with the problem of the peopling of the New World by migrants from Siberia. Archeological work was continued on the site in Colorado where Folsom man, the earliest known inhabitant of this continent, made weapons and tools used in hunting extinct animals that flourished during the closing days of the last ice age.

Important Arabic, Chinese and Persian manuscripts, paintings and art objects were added to the collection of the Freer Gallery of Art; and 312,729 specimens were added to the collections of the National Museum.

AWARD TO PROFESSOR WOOD OF THE RUMFORD MEDAL OF THE ROYAL SOCIETY

THE Rumford Medal of the Royal Society, London, as already announced in SCIENCE, was awarded at the seventy-fifth anniversary meeting of the society on November 17 to Professor Robert Williams Wood, professor of experimental physics at the Johns Hopkins University. The medal has now been received in Baltimore by Dr. Wood, who was unable to attend the ceremony. It weighs fifteen ounces and is about three inches in diameter. On its surface is a profile of Count Rumford. With it was sent a silver replica of the medal.

Accompanying the medal was the following citation of Sir William Bragg, president of the society, which was read at the anniversary meeting:

Professor Robert Williams Wood is awarded the Rumford Medal. The study of physical optics owes much to Professor Wood, who has been one of the leading experimenters in this field for the past 40 years. There is hardly a branch of the subject which he has not enriched by the touch of his genius.

Before the advent of Bohr's quantum theory, when our knowledge of the structure of atoms and molecules was very meager, he had discovered the line and continuous absorption of sodium vapor, the phenomenon of resonance radiation of gases and vapors, and the quenching of this radiation by foreign gases. These discoveries opened up rich fields of research and were of the greatest value to later workers in laying the foundations of the theory of atomic and molecular spectra.

The elucidation of the phenomenon of resonance radiation demanded the utmost experimental skill and resource. Nothing less powerful than an improvised 40-foot focus spectrograph sufficed for his work on the remarkable resonance spectra of molecules! Even now one can not but admire the beautiful and ingenious experiments on the independent excitation of the yellow sodium lines.

In addition to his researches on the resonance radiation of metallic and other vapors, Wood investigated their magnetic rotation and dispersion. His work on the magneto-optics of sodium vapor both in the atomic and molecular state is now classical.

More recent but belonging to the same domain of experiment are the very interesting discoveries of Wood and Ellett on the magneto-optics of resonance radiation.

Wood's mastery of technique is universally acknowledged. He has introduced many ingenious and striking devices to experimental method. These are too numerous to catalogue here, but I would mention specially his method of the production of atomic hydrogen and his observations on the spontaneous incandescence of substances in atomic hydrogen which led to the invention of the atomic hydrogen welding torch by Langmuir; his very efficient and now widely used method of observing Raman Spectra; his échelette grating which has proved to be the grating *par excellence* for the investigation of the near and far infra-red, and his pioneer use of light filters in ultra-violet and infra-red photography.

SCIENTIFIC NOTES AND NEWS

ON the occasion of the sixtieth birthday of Professor Howard T. Karsner, director of the Institute of Pathology and for twenty-five years professor of pathology at Western Reserve University, his associates and former pupils commemorated the event by presenting him with his portrait, painted by Rolf Stoll, head of the department of portraiture of the Cleveland School of Art. The event took place at a tea in honor of Professor and Mrs. Karsner on January 6, at the Institute of Pathology. Preceding the tea, the fac-

ulty of the School of Medicine gave a surprise luncheon at the Cleveland Club in honor of Professor Karsner.

THE annual award of the Pittsburgh section of the American Chemical Society has been made to George Hubbard Clapp. The award, an aluminum plaque suitably inscribed, which will be presented at a meeting of the society on February 16, is made "in recognition of outstanding service to chemistry in the Pittsburgh District." Mr. Clapp, who recently celebrated his eightieth birthday, is a member of the Board of Directors of the Aluminum Company of America, president of the Board of Trustees of the University of Pittsburgh, a life member of the board of the Carnegie Institute of Technology and chairman of the Museum Committee.

THE annual Lawrence Sperry Award given by the Institute of Aeronautical Science "to the young man making the greatest contribution to the advancement of aeronautics during the year" has been given to Russell Conwell Newhouse, of Orange, N. J., a member of the technical staff of the Bell Telephone Laboratories, New York City. The award is made for the development of the terrain clearance indicator, a device which indicates the altitude of an airplane over the terrain immediately below, whether it be water, land or buildings. The award with a check for $250 will be presented to Mr. Newhouse at the honors night dinner of the institute on January 27.

A GOETHE MEDAL has been awarded to Dr. Eugen Korschelt, professor of zoology and comparative anatomy at the University at Marburg.

THE Laura Leonard Prize of the German Society for the Study of Colloid Chemistry has been awarded to Professor M. Samec, of Ljubljana, Yugoslavia, for his work on the colloidal chemistry of starch.

DR. JULIAN PARK, dean of the College of Arts and Sciences of the University of Buffalo, has returned from France, where he received on December 3 the degree of *docteur honoris causa* from the University of Dijon.

DR. RAYMOND PEARL, professor of biology in the School of Hygiene and Public Health at the Johns Hopkins University, was elected at the Detroit meeting president of the American Statistical Association.

THE Berlin Society for Anthropology, Ethnology and Pre-history, of which Dr. Franz Boas, emeritus professor of anthropology at Columbia University, was a corresponding member, has discontinued his membership "on account of reliably reported hostility to present Germany."

AT a meeting of the History of Science Society held in Chicago on December 29 and 30, the following officers were elected for the year 1939: *President,* Henry E. Sigerist, Baltimore; *Vice-presidents,* Richard H. Shryock, Philadelphia, and Louis C. Karpinski, Chicago; *Secretary-Treasurer,* Henry R. Viets, Boston; *Council,* F. R. Moulton, Washington; Hans Fischer, Zurich; C. L. G. Pratt, Oxford; Kenneth J. Franklin, Oxford; Erik Waller, Lidkoping, Sweden.

THE Torrey Botanical Club held its annual meeting and banquet at the Faculty Club, Columbia University, on January 3. The following officers were elected: *President,* A. H. Graves; *First Vice-president,* G. T. Hastings; *Second Vice-president,* Miss Cornelia L. Carey; *Treasurer,* H. N. Moldenke; *Corresponding Secretary,* J. S. Karling; *Recording Secretary,* Miss C. Chandler; *Editor,* R. P. Wodehouse, and *Business Manager,* M. Levine.

DR. WILLIAM S. MCELLROY has been elected dean of the School of Medicine of the University of Pittsburgh. He has been acting dean of the school since the death of Dean Raleigh Russell Huggins in February, 1938.

DR. HARRY W. CRANE, professor of psychology at the University of North Carolina, has resigned as director of the Division of Mental Hygiene of the North Carolina State Board of Charities and Public Welfare, a position that he has held part-time since 1921, in order to accept the post, also part-time, of psychological consultant to the Health Center of the university.

DR. HERBERT B. WILCOX, professor of diseases of children at the College of Physicians and Surgeons of Columbia University, has been appointed director of the New York Academy of Medicine to succeed Dr. John A. Hartwell, who has resigned. The change will take place on April 1.

DR. ERROL IVOR WHITE has been appointed deputy keeper in the Department of Geology of the British Museum (Natural History), and Frederick Allan Bannister has been appointed deputy keeper in the Department of Mineralogy. A. G. Gabriel, technical assistant in entomology, has been promoted to assistant keeper. William B. Fagg has been appointed assistant keeper in the Department of Ethnography.

DR. SYLVANUS GRISWOLD MORLEY, of the Carnegie Institution of Washington, sailed on January 9 for Yucatan. This is his thirty-second annual visit. Members of the party include Frans Blom, director of the Middle American Research Institute of Tulane University, and Gerhard Kramer, associate in architecture.

DR. STANHOPE BAYNE-JONES, dean of the School of Medicine of Yale University, recently spent a few days as guest of the faculty of the School of Tropical Medicine at San Juan, Puerto Rico. While in San Juan he gave a lecture on "Recent Advances in Cancer Research."

DR. BRONISLAW MALINOWSKI, professor of anthropology at the University of London, is spending the winter in Tucson, Arizona.

PROFESSOR O. A. BROWN, of the department of electrical engineering of the Iowa State College, has leave of absence to accept a position with the United States Government as associate electrical engineer. He will work at Washington on problems of agricultural engineering.

DR. HOSMER W. STONE, assistant professor of chemistry at the University of California at Los Angeles, has been invited to continue his research on oxidation reduction indicators at the University of Copenhagen. He plans to sail during the first week of February and to return to California in December.

PROFESSOR LAMERT S. CORBETT, dean of men and head of the department of animal industry at the University of Maine, has been granted for reasons of health leave of absence during the present half year.

DR. STACY R. METTIER, associate professor of medicine in the University of California Medical School, has six months leave of absence and has sailed for England, where he will study hematology and the leukemias, under the auspices of the Nuffield Foundation, with Professor L. J. Witts, head of the department of medicine at the University of Oxford.

THE Phi Sigma lecture was given on January 15 at Marquette University, Milwaukee, by the Rev. A. M. Schwitalla, professor of biology and dean of the Medical School at St. Louis University. His subject was: "The Importance of the Cell Theory and Its Application to Modern Biological and Medical Problems."

CLIFFORD C. GREGG, director of the Field Museum, Chicago, spoke at the ceremonies marking the opening of a new wing in the Museum of Science of the St. Paul Institute on December 1. His topic was: "The Place of the Local Museum in Its Community."

DR. JAMES BONNER, of the California Institute of Technology, recently addressed the Utah Chapter of Sigma Xi in Salt Lake City on "Recent Developments in the Study of Plant Growth."

DR. WALTER C. ALVAREZ, of the Mayo Foundation, delivered the third of the laity lectures of the New York Academy of Medicine on January 12. He spoke on "The Emergence of Modern Medicine from Ancient Folkways."

DR. WILLIAM H. HOBBS, professor emeritus of geology, University of Michigan, gave a lecture before the Lancaster Branch of the American Association for the Advancement of Science on January 19. The lecture, which gave an account of his three expeditions to Greenland, was entitled "Exploring about the North Pole of the Winds."

DR. EMMETT B. CARMICHAEL, professor of physiological chemistry, School of Medicine, University of Alabama, was the principal speaker on December 9 at the installation of the Mississippi Beta chapter of Alpha Epsilon Delta, national honorary premedical fraternity, at the University of Mississippi, and of the Mississippi Gamma chapter at Mississippi State College on December 10. Drs. W. F. Hand, Clay Lyle and J. W. Ward, of the college faculty, were initiated as honorary members of the Mississippi Gamma chapter. Dr. Ray J. Nichols, professor of biology, is faculty adviser of the chapter at the University of Mississippi.

THE two hundred and twenty-sixth regular meeting of the American Physical Society will be held in New York City on Thursday, Friday and Saturday, February 23, 24 and 25, 1939, as a joint meeting with the Optical Society of America and the Inter-Society Color Council. The sessions of the Inter-Society Color Council will be held on Thursday, February 23, at 480 Lexington Avenue, and those of the American Physical Society and the Optical Society of America on Friday and Saturday, February 24 and 25, will be held at Columbia University in the Pupin Physics Laboratories. A special symposium on television will be held probably on Saturday morning. Invited papers will be presented by V. K. Zworykin and Philo T. Farnsworth. It will be concluded with a demonstration of television reception which will be presented by A. F. Van Dyck. There will be a morning business session of the Color Council, an afternoon technical session on "color tolerance" sponsored jointly by the American Psychological Association, an evening popular session and a "Parade of Color," to consist of recent or interesting color developments in the fields covered by the various member bodies of the council.

THE spring meeting of the Electrochemical Society will be held at Columbus, Ohio, from April 26 to 29. Headquarters will be the Deshler-Wallick Hotel. Professor James R. Withrow, of the Ohio State University, is chairman of the local committee. The two main sessions of this meeting will be devoted to organic electrochemistry, under the chairmanship of Sherlock Swann, Jr., and refractories, under the direction of L. J. Trostel.

THE annual general meeting of the American Philosophical Society will be held on April 20, 21 and 22, beginning at 10 A. M. on Thursday, April 20.

THE sixth Australasian Medical Congress will meet in Perth, Western Australia, in August, 1940. The main theme of the congress will be "Rheumatic and Allied Disorders."

THE American Physical Society and the American Association of Physics Teachers held their annual

meetings at the National Bureau of Standards in Washington on December 27 to 30. Over 400 persons registered for the meetings, including 315 from out of town. Seventy-nine papers were presented. The address of the retiring president, Dr. Lyman J. Briggs, on "The National Standards of Measurement," was followed by an inspection of these standards in the laboratories of the bureau. The joint dinner was attended by nearly 300 persons and was followed by a lecture by Dr. Harvey Fletcher on "Auditory Patterns," with experimental demonstrations. The next evening Professor P. W. Bridgman addressed the physics teachers on "Society and the Intelligent Physicist." The new officers of the American Physical Society are: John T. Tate, *president;* John Zeleny, *vice-president;* W. L. Severinghaus, *secretary,* and Geo. B. Pegram, *treasurer.*

THE National Advisory Cancer Council has recommended to the Surgeon General a grant of $11,900 to Cornell University Medical College, New York City, for work during a period of two years by Dr. Dean Burk, under the direction of Dr. Vincent du Vigneaud, professor of biochemistry, on cell metabolism fundamental to cancer, with the understanding that for the purposes of this study Dr. Dean Burk may be appointed a fellow in the National Cancer Institute.

THE Committee on Scientific Research of the American Medical Association invites applications for grants of money to aid in research on problems bearing more or less directly on clinical medicine. Preference is given to requests for moderate amounts to meet specific needs. For application forms and further information, apply to the committee at 535 North Dearborn Street, Chicago, Illinois.

DISCUSSION

BIOLOGICAL RESEARCH FILMS

IN view of the now considerable number of research films that have been produced in various widely distributed laboratories it appears highly desirable that these films be collected at some central point. Not only would such a collection serve to record, index and make available these valuable data, but also it should be useful to encourage and improve the quality of future research films.

It has been suggested that a cross-indexed and abstracted collection of such films relating generally to biological research be established at the Marine Biological Laboratory, Woods Hole, Mass. The plan, as outlined below, has received approval from the director of the laboratory and from the managing editor of the *Biological Bulletin,* providing a sufficient interest is expressed by biological investigators and others who have already made or who plan to use films in their research or teaching.

The collected suggestions of nine investigators who have produced films appear to crystallize around the following three interrelated points: (1) The establishment of a centrally located film library. (2) Appointment of an editorial board of film reviewers. (3) Publication of collected film abstracts in a recognized journal.

(1) The Marine Biological Laboratory as an independent institution, already equipped with an almost unequalled library and being visited by the most representative cross-section of biologists, seems a logical choice for location. As part of the library activities, one print together with a complete negative including titles should be submitted for cataloguing and permanent storage. At first, the author or his department might donate either the master negative or a copy, while the laboratory (if a source of funds can be found) could supply the positive.

(2) To assume responsibility for the plan's operation, it would be necessary for the trustees of the laboratory to appoint a board of review, consisting of three members. Its function would include passing upon the films submitted, rejecting those imperfectly titled, photographed or organized. In this manner the quality of films might be improved from year to year. Preference would be given those films of primary interest to workers in the Marine Biological Laboratory.

(3) To provide a running catalogue of the collection, a one-page abstract of each film accepted would be published annually in a winter issue of the *Biological Bulletin,* under separate heading, such as the *Biological Film Bulletin* or *Film Supplement.* Whenever desirable it is planned to print one or two frames from the film with each abstract. Copies of abstracts would be furnished to authors under the same conditions as hold for papers now published, and eventually the collected abstracts might be published in pamphlet form.

Even should the first years of operation of the above plan result in only few films being placed on record, it is nevertheless hoped that biological research will be substantially aided. It may become desirable to furnish at reasonable cost extra prints (approximately $15.00 per reel) to institutions and to individuals who request them. However this latter suggestion may considerably increase the sum of three hundred dollars now necessary to start the plan. For the present, rental of the films seems out of the question.

It is earnestly requested that all those interested in

this plan will forward to the undersigned their own suggestions and criticisms, together with a definite statement as to the conditions under which they would be willing to submit both new and old negatives or prints to the Marine Biological Laboratory film collection. It would also be extremely helpful if any interested in obtaining extra prints from such a collection would communicate with us. Needless to say, furtherance of the plan will depend almost wholly upon the response from readers of this note.

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ROBERT CHAMBERS

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NEW YORK UNIVERSITY

ANOTHER TREATMENT OF THE UNITS FOR F = ma

IN the October 14, 1938, issue of SCIENCE Professor Perkins says that there are only two essentially different ways of handling gravitational measures of force. I am not quite sure what Professor Perkins would call *essentially* different, but there is certainly another way which looks different and does not involve some of the difficulties which he discusses.

Let us use only $F = ma$. The quantities are all to be measured in units from Table 1 and for a particular problem must all come from the same horizontal row of the table.

TABLE 1

		Length	Time	Mass	Force	Energy
Absolute ...	Metric	cm	sec	gm	dyne	erg
	English	ft	sec	pound	poundal	ft poundal
Gravitational or Engineering	Metric	cm	sec	metric slug	gm-f	gm-f cm
	English	ft	sec	slug	pound-f	ft pound-f

The pound-f and gm-f are defined as the weight of a pound mass and gm mass respectively.
The slug and metric slug are defined as the masses to which a pound force and gram force respectively will give unit acceleration (1 ft/sec², 1 cm/sec²).
K.E. $\frac{1}{2}mv^2$, $F_c = mv^2/r$, Work = Fs = change in potential energy.

We do not expect other formulas to be so written that we can enter them without first reducing the quantities involved to certain particular sets of units and still have the answer in terms of familiar units. We should do the same with $F = ma$.

With this treatment, only a single set of formulas is needed. Furthermore, no "g's" are scattered over these formulas like salt over a plate of food. In this country at present it is hardly possible to ignore "ft lb" of energy and horse power (= 550 ft lb-f per sec). Hence, however much the physicists would like to forget gravitational units, they must continue to teach both systems, but that does not need to mean that there must be two sets of formulas.

NIEL F. BEARDSLEY

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THE MOVEMENT OF WATER FROM CONCENTRATED TO DILUTE SOLUTIONS THROUGH LIQUID MEMBRANES

IN the experiment of W. J. V. Osterhout and J. W. Murray[1] recently commented on by H. E. Bent[2] it appears to us that the permeability of the membrane for the solvent as well as for the solute deserves special consideration.

If the membrane were permeable only for the solvent there would be a contradiction of the second law of thermodynamics. However, the fact that the solute is simultaneously transferable contributes a positive reduction in free energy which fully compensates the work required for the apparently anomalous movement of a certain amount of solvent.

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THE AMERICAN ASSOCIATION OF SCIENTIFIC WORKERS

IN a recent issue of SCIENCE (December 16, 1938) the announcement was made of the formation of a branch of the American Association of Scientific Workers in Boston and Cambridge, Mass. It is hoped to establish similar branches of this association in various centers as a means of bringing together scientists of different disciplines to study the problems of science and society and to endeavor to give effect to the natural desires of scientists as members of democratic society. Its program is in accord with publicly expressed opinions of prominent men of science, including leaders of the American Association for the Advancement of Science, and it is hoped that active groups of the American Association of Scientific Workers and individual members will be able to cooperate with the American Association for the Advancement of Science in its activities in the field of science and society.

Not long after the founding of the American Association of Scientific Workers the following letter was received from Sir F. Gowland Hopkins, president of the Association of Scientific Workers in Great Britain and a past president of the British Association for the Advancement of Science and of the Royal Society:

I am much interested to learn of the foundation of the American Association of Scientific Workers, whose policy and program are so closely parallel to those of the Association of Scientific Workers in Great Britain.

In these days when science plays so great a part in every field of modern life it is essential for scientific workers to organize, both to protect their own economic and professional status and to work for the better organization and application of science for the benefit of the com-

[1] SCIENCE, 87: 430, 1938.
[2] SCIENCE, 88: 525, 1938.

munity. These problems are not confined to one country, and the Association of Scientific Workers welcomes the formation of a brother organization in America.

On behalf of the Association of Scientific Workers I would like to express the hope that you will receive great support from all scientific workers in America, and to wish you success in carrying out your policy.

At present the headquarters of the association is in Philadelphia, and we would be glad to receive inquiries from scientists in centers where there is not yet a local branch.

DONALD HORTON,
Corresponding Secretary

PHILADELPHIA, PA.

SCIENTIFIC BOOKS

CHARLES DARWIN

Charles Darwin. A Portrait. By GEOFFREY WEST. New Haven; Yale University Press. 1938. Pp. 359.

I TOOK up this volume with a feeling of prejudice; how could such an author, even after some years of diligent compilation, be in a position to appreciate Darwin's scientific work? Turning over some of the pages I found passages which confirmed my fears, and debated with myself whether to return the book to the editor unreviewed. Nevertheless, when I settled down to read the book page by page I had to admit that the recorded facts concerning Darwin had been collected with the utmost diligence, arranged with great care and set forth in a manner which made the book easy and profitable to read. With a reasonable amount of revision or expurgation, which I presume the author would not permit, the book might be described as a very satisfactory and illuminating biography. One can easily imagine the other side of the argument. It might well appear that after all a scientific worker who has grown up and lived in the Darwinian tradition was himself incapacitated for forming an impartial judgment. Morley, in writing the life of Gladstone, said that people would probably accuse him of partiality. He said that he would be sorry to be thought lacking in this quality; and one who is indebted to Darwin's influence in so many ways that it has formed a kind of atmosphere in which he has lived, cannot regard the matter with cold objectivity, or even wish to do so. It must be said of Mr. West, that throughout he regards his hero with respect and even affection, and shows little of the cheap cynicism with afflicts many biographers. He discusses the various personal and scientific matters, as they come up, with a lucidity which I fear few professional scientific workers could attain, and no one can read all this without profit. The available record as it stands probably does not do justice to the maturity of Darwin's mind when he sailed on the "Beagle." Having visited regions in South America which he described, I have been amazed at the accuracy and sagacity of his observations. I do not know who, to-day, could take such a comprehensive and understanding view of nature in a remote country visited for the first time. So again, his one important contribution to taxonomy, his monograph of the living and fossil barnacles, has stood the test of time as few such works have. This is the testimony of Pilsbry, the principal living authority on these animals. West's final chapter is headed "The Fragmentary Man," and he reaches the conclusion that "Darwin was incomplete and Darwinism accordingly inadequate as a philosophy by which men may live." I should put it differently. Darwinism is dynamic, and is not to be thought of as the basis of a static philosophy, nor does it pretend to deal with all aspects of reality. Since Darwin's time many important discoveries have been made, and were he living to-day, he would be the first to take account of them. The artist completes a work, and no one dares tamper with it; the scientific man, in contrast, is always on the road, never at the journey's end. In that sense all scientific work is fragmentary and incomplete, but this should not imply reproach. Considering his physical disabilities, and the limits of even the greatest human mind, Darwin was marvelous in his power of comprehending the larger aspects of nature, and the details of many matters. If he neglected subjects which we deem important we have no more right to complain than we should in the case of a noted pianist who did not play the flute.

The cry "back to Darwin" may have vitality to-day, as an encouragement to broader training and wider views, rather than the narrow specialization which is fostered by our educational methods. In this case, in spite of Mr. West's conception of Darwin as a "fragmentary man," I believe that his book will teach a different lesson, and may be read with profit as a stimulus to constructive thought and work.

T. D. A. COCKERELL

CONVERGENCE

A Text-book of Convergence. By W. L. FERRAR. Oxford University Press, 1938. viii + 192 pp. Price, $3.50.

As the title indicates, this book is a *text* on the theory of series. In the opinion of the reviewer it is clearly and carefully written, in a pleasant style, with good (albeit conventional) choice of material.

The subject-matter includes preliminary definitions

of limit (especially well done), study of monotonic sequences, series of positive terms, comparison and ratio tests, alternating series, the Cauchy condition, uniform convergence, binomial and logarithmic expansions, integral tests, double series, Cesàro sums, Fourier series.

There are several unusual features of the book. (i) The now standard shorthand, such as:

$$\alpha_n \to 0 \text{ } if$$
$$\varepsilon > 0;\ EN \cdot |\alpha_n| < \varepsilon \text{ } when \text{ } n \geqq N,$$

is introduced early, explained thoroughly and used consistently throughout the work. This is a great advantage in conciseness and clarity. (ii) The author divides all (real) series into three classes: convergent (when the sum S_n of the first n terms approaches a finite limit), divergent (when S_n becomes positively or negatively infinite), non-convergent (when S_n approaches no finite or definitely infinite limit). This classification is not commonly used, but is entirely appropriate. It is more discriminating than the usual classification, and notably more precise in such topics as power series and Abel's theorem. (iii) The book contains numerous well-graded and illuminating exercises. These are in part applications of the theory developed, in part elaborations of it; they alone are sufficient to justify the publication.

There are a few matters in which the reviewer fails to see eye to eye with the author. (i) The latter is not entirely consistent in his use of divergence, for he admits (p. 17) the notation $\alpha_n \to +\infty$, he asserts (p. 22) that if $S_n \to S$ then S is called the sum of the series, he later (p. 23, § 2.1) considers that a series has a sum if and only if S_n tends to a *finite* limit. (ii) More figures and better ones would be an aid to the beginner. For instance, the figures (pp. 84, 85) illustrating uniform convergence are not as closely related to the details of the definition as one might expect.[1] (iii) In proving (p. 84) the theorem on term-by-term integration in a finite interval of a uniformly convergent series, the author does not require continuity of the terms of the series, hence needs to *assume* the integrability of the sum of the series; he omits the remark that this condition is automatically fulfilled if the terms of the series are continuous. (iv) In the chapter on Fourier series, the author does not mention the least-square property of the partial sums; this omission is probably due to a desire to save space, but the property is an important one and can be established in a few lines. (v) The only general convergence theorem proved on Fourier series is that (granted integrability of the given function) of the series where convergent represents the average of the limits (assumed to exist) of the function approached from the right and left. This theorem is no shorter to prove and in the judgment of the reviewer much less interesting to the student (and to the physicist!) than the proof of convergence for functions say satisfying Dirichlet's condition, or even for functions that are piecewise smooth.

Despite these and other criticisms, the reviewer considers the book highly useful for undergraduates, especially when it is supplemented by lectures or tutorial instruction, and wishes it a wide-spread use in this country.

J. L. WALSH

HARVARD UNIVERSITY

[1] Contrast, for instance, Osgood, Funktionentheorie I (Leipzig, 1928), pp. 97, 98.

SPECIAL ARTICLES

A METHOD OF EXTINGUISHING THE REFLECTION OF LIGHT FROM GLASS

H. D. TAYLOR discovered in 1892 that a tarnished photographic lens transmitted more light than a new lens. Since his discovery, several workers[1, 2, 3] have investigated means of treating glass surfaces so as to diminish the reflection and consequently increase the transmission of light by the glass.

Recent experiments have led to a method of coating glass with a film which extinguishes reflected monochromatic light. The film is made in such a way that the light reflected from the outer surface is equal in intensity and opposite in phase to the ray reflected from the glass-film surface. Under these conditions no light is reflected.

In order that a film shall have the property of extinguishing perpendicular light the film must fulfil the following two conditions:

(*a*) The substance of which the film is made must have a refractive index n_1, which has a value given by the equation

$$n_1 = n_0 n_g \qquad (1)$$

where n_g is the refractive index of the glass, and n_0 of the medium in which the glass is viewed which is commonly air.

(*b*) The film must have an optical thickness $n_1 t$, which is given by the equation

$$n_1 t = 0.25\,\lambda\,(2a + 1) \qquad (2)$$

where t is the thickness of the film and a is zero or an integer. A film having a thickness corresponding to the first order of interference, *i.e.*, a film for which $n_1 t = 0.25\,\lambda$, is far more effective in diminishing reflec-

[1] F. Kollmorgen, *Trans. Soc. Illuminating Engineers*, 11: 220, 1916.

[2] Ordnance Department Document, No. 2037, p. 76.

[3] J. Strong, *Jour. Optical Soc. America*, 26: 73, 1936.

tion when *white light* is used than films corresponding to minima of higher orders for which $a = 1, 2, \ldots$ etc.

Built-up films of the soaps of fatty acids[4, 5] have provided a substance which can be treated in such a way as to have the value of refractive index which is required by Eq. (1) for the case of ordinary glass ($n_g = 1.52$) or for any glass of higher refractive index. The films are unfortunately soft and can be wiped from the glass with a cloth. However, they provide an extraordinarily useful tool for studying the application of the phenomena of interference to problems of light reflection.

The substance of which a built-up film is commonly composed is a mixture of a fatty acid and of the soap of a fatty acid. Thus the composition of Y-films of so-called "barium stearate" is about 50 to 80 per cent. barium stearate, and the remainder is stearic acid. When films of this substance are soaked in a solvent for stearic acid, the film is left as a skeleton of barium stearate, with air filling the spaces previously occupied by the stearic acid.

If a film has initially a refractive index $n_1 = 1.50$, and if 50 per cent. of the material is removed without causing the film to shrink in thickness, the refractive index of the skeleton is 1.232. This is the value of n_1, which serves to extinguish the reflection of light from glass $n_g = 1.518$; that is, from glass of the type of ordinary window glass.

Skeleton films can be built of cadmium arachidate, which are better in optical quality than those built of barium stearate. The films are built by spreading arachidic acid in a monolayer on the surface of a bath which is 10^{-4} M cadmium chloride, 10^{-3} M sodium acetate, 1.2×10^{-4} M HCl, pH 5.7. They are built to the desired thickness on both sides of a plate of glass by the ordinary methods used in making built-up films. The thickness of a film having 42 or 44 layers of skeletonized cadmium arachidate is a quarter wave-length of sodium light. The built-up film is soaked for about 2 minutes in alcohol, and then in acetone at 35° C–40° C until the refractive index has decreased to the extinction value.

A film built in this way completely extinguishes the reflection of sodium light, and nearly extinguishes all visible light of other wave-lengths. When a plate of ordinary glass is placed a few inches from a 6,000-lumen sodium vapor lamp, with a black background behind the plate, the glass reflects a bright glare of yellow light, whereas if the glass is coated with a non-reflecting film the coated area appears as black as black velvet. A stripe of this type of film, built on a plate of glass, increases the transmission of light from 92 per cent. for clean glass to 99.2 per cent. for the film-coated glass. When one looks through the glass at the sky or at a sheet of white paper, the stripe has the appearance of clean glass, and the clean glass on either side of the stripe appears to be slightly smoked.

The difference in reflection is particularly striking in the case of the type of glare which prevents an observer from seeing objects which are behind a glass window. For example, one half of the glass cover of an instrument meter was coated with a non-reflecting film, and the contrast between the coated half and the uncoated half was so striking that observers seeing this instrument for the first time were deceived by the illusion that there was no glass on the film-coated half.

A paper describing the full details of this work will be published in the near future.

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[4] K. B. Blodgett, *Jour. Am. Chem. Soc.*, 57: 1007, 1935.
[5] K. B. Blodgett and I. Langmuir, *Phys. Rev.*, 51: 964, 1937.

CITY AIR SEARCHED FOR SULFUR FUMES

RESULTS of a 15-month survey to determine the *average* amounts of sulfur gases in the air of American cities, long a subject of speculation and dispute, are announced by Air Hygiene Foundation and Mellon Institute. The average amounts of sulfur fumes found in 25 cities studied were comparatively small.

More than 50,000 separate air tests were made by six chemists driving a fleet of cars equipped like "traveling laboratories." They canvassed industrial and residential centers throughout the East, South and Midwest, from August, 1936, to October, 1937. Most of the tests, covering all hours of day and night and all seasons of the year, were made in five metropolitan districts. The five, in the order of their sulfur dioxide pollution, are given in Table 1 (figures indicate parts of sulfur dioxide per million parts of air).

TABLE 1

City	Within 15-mile radius of center of city	
	Average	Maximum
St. Louis—East St. Louis ...	.128	2.266
Pittsburgh	.057	.897
Detroit	.028	.396
Philadelphia—Camden	.027	.424
Washington	.009	.290

The above figures are of no significance from a public health standpoint, according to hygienists connected with the investigation. That is, "in the concentrations found, the contaminants do not exert harmful physiological effects."

The survey showed that the home fires are among the large contributors to sulfur pollution, particularly in districts using coal of high sulfur content. The type of coal burned in a locality was mirrored in the

results of the study. The fuel factor also explains why sulfur pollution in most districts was approximately 50 per cent. higher in the "heating season" than in the summer months. Some industrial operations also discharge sulfur fumes, unless properly safeguarded.

A close relationship was found between wind velocity and the amount of sulfur dioxide in the air. The higher the wind the cleaner the air. Fogs catch and "store up" the sulfur fumes. Some of the highest concentrations were noted on foggy nights.

Occasional tests were made in a score of other cities. Dr. H. B. Meller, managing director of Air Hygiene Foundation, cautioned that results obtained in these cities can not be compared with the findings for St. Louis, Pittsburgh, Detroit, Philadelphia-Camden and Washington. He pointed out that "only a few tests were made in this group, not enough to arrive at a typical, average figure, as in the case of the five centers which formed the backbone of the survey." Results for the 20 other cities are given in Table 2.

TABLE 2

City	Summer average	Winter average
Baltimore	.021	.081
Chicago	.067	.091
Cleveland	.064	.081
Wheeling	.070	...
Nashville	.028	.093
Cincinnati	.021	.064
Buffalo	...	.044
Youngstown	.049	.026
Louisville	.022	.041
Ft. Wayne	.028	...
Richmond	.009	.047
Indianapolis	.023	...
Toledo	.023	...
Chattanooga	.011	.035
Springfield, Ill.	.021	...
Birmingham	.017	.017
Charlotte, N. C.	.015	...
Johnstown	.014	...
Harrisburg	.011	...
Atlanta	.012	.032

J. D. Alley directed the field work and compilation of data. Dr. J. L. Sherrick was in charge of the chemical laboratory. Both were fellows on the Air Hygiene Foundation Fellowship at Mellon Institute. Six chemists were employed in the field. One operated a "rover" laboratory, visiting a score of cities. The others were stationed in the five metropolitan districts described.

Each of the five field men traveled a prearranged route, covering about 130 designated stations in each of the five districts. The stations were scattered through business districts, parks, industrial sections and residential neighborhoods, and ranged from the center of a city to 25 or 30 miles in the suburbs. This was done to determine the *average concentration* rather than temporary "peaks" and "lows."

The field chemists worked a "staggered" schedule, 8 A.M. to 4 P.M., one week, 4 P.M. to midnight the next, etc. Their day off was also rotated. Thus over a period of 15 months they obtained comprehensive checks on sulfur concentrations for each hour of the 24, each day of the week and each season of the year.

JOHN F. MCMAHON

THE NATURE OF THE CARBOHYDRATE IN THE GONADOTROPIC SUBSTANCE OF PREGNANCY URINE

THE presence of carbohydrate in gonadotropic hormone preparations from pregnancy urine has been observed by numerous investigators. Fischer and Ertel[1] have stated that the properties of their relatively crude material agreed closely with urinary mucoid and ovomucoid, while Meyer,[2] working with highly active preparations, also characterized the hormone as a mucoid. Hartmann and Benz[3] have very recently reported studies of the carbohydrate of their APL hormone preparations, but were unable to decide whether their material contained mannose, galactose or a mixture of both. They published no details regarding the purity of their product.

By a process which will shortly be published in detail, hormone preparations have been made assaying 1,000 to 3,000 units per milligram by the Friedman rabbit assay method. These fractions contain carbohydrate, hexosamine and acetyl groups[4] as previously found by Meyer[2] in his preparations. Pentose, ketohexose and uronic acid were shown to be absent.

Our early determinations[4] of reducing sugar by the Hagedorn-Jensen procedure gave values that were too high as a result of errors produced by the accompanying products of protein hydrolysis. Clarification with $Zn(OH)_2$ did not materially lower the figures. Similar errors have been observed by Mundy and Seibert[5] as well as Hewitt.[6] The Shaffer-Hartmann method, however, yields lower results.

Using suitable methods we have obtained evidence to indicate that our purest preparations contain 2 hexose groups for each hexosamine. Assuming that the carbohydrate in the hormone is composed of trisaccharide units containing 1 hexosamine and 2 aldohexose groups, we have compared two of our best preparations with the commonly occurring aldohexoses by means of the carbazole[7] and orcinol reactions.[8]

[1] F. G. Fischer and L. Ertel, *Zeit. physiol. Chem.*, 202: 83, 1931.

[2] K. Meyer in R. Kurzrock, "Endocrines in Obstetrics and Gynecology," p. 116. Williams and Wilkins, 1937.

[3] M. Hartmann and F. Benz, *Nature*, 142: 115, 1938.

[4] S. Gurin, C. Bachman and D. Wright Wilson, *Jour. Biol. Chem.*, 123: proc. xlix, 1938.

[5] B. Munday and F. B. Seibert, *Jour. Biol. Chem.*, 100: 277, 1933.

[6] L. F. Hewitt, *Biochem. Jour.*, 32: 1554, 1938.

[7] Z. Dische, *Mikrochemie*, 8: 4, 1930.

[8] J. Tillmans and K. Philippi, *Biochem. Zeit.*, 215: 36, 1929.

The color produced by the hormone preparation in the carbazole reaction was compared with those yielded by glucose, mannose, galactose and equimolar mixtures of all the pairs of these sugars. Determinations of the relative transmission of light in the spectral regions 420, 520, 540 and 660 mμ were made by means of an Evelyn photoelectric photometer. The characteristic ratios of extinction coefficients at two wave-lengths (*e.g.*, 420 and 520 mμ) for glucose, mannose, glucose-galactose and galactose-mannose were found to be different from that given by our hormone preparations, while galactose and a glucose-mannose mixture could not be distinguished from the hormone by this method.

To differentiate between our hormone preparation and galactose or a glucose-mannose mixture the orcinol method as modified by Sörensen and Haugaard[9] was utilized. Solutions of the hormone preparation, galactose and the glucose-mannose mixture (each in 3 different dilutions) were heated 20 minutes at 80–81° with the orcinol reagent and the colors compared at 420 and 520 mμ. The ratios of the extinction coefficients for our preparations and the glucose-mannose mixture were different, while those for the hormone preparation and galactose were similar.

As both the orcinol and carbazole methods gave ratios of extinction coefficients for our hormone preparations which agreed well with those obtained for galactose, we conclude that the nonhexosamine sugar of our gonadotropic hormone preparations consists entirely of galactose units. Obviously final proof of the nature of the carbohydrate must await its isolation and characterization. It must be further emphasized that the presence of several galactose units along with a single different hexose molecule would be extremely difficult to detect by the methods we have employed. However, we consider this possibility to be unlikely.

Further details of the above study will be published shortly.

We wish to thank the American Philosophical Society and the National Research Council for financial assistance.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

INTRAVENOUS INFUSION PUMP[1]

FOR intravenous infusion in animals, it is desirable to have an automatic device which is simple, is easily adjusted to deliver various amounts and has a high degree of accuracy. The following apparatus seems to meet these requirements and is designed and used for the digitalis cat-assay. It consists essentially of a stopcock, turned by a constant speed motor, which in one position connects a pipette with a reservoir from which it is filled and in the other position connects the pipette with the vein into which it empties (see Fig. 1). The filling level (F) of the pipette is determined by the position of the reservoir. The emptying level (E) is determined by the position of a device which makes it independent of venous pressure variations, and which has been used in a perfusion method for isolated organs with constant volumes of fluid[2]: The venous canula is connected with the lower end of a vertical glass tube (25 cm length, 0.4 cm inside diameter), which has a short T arm sealed close to its open top. One opening of the stopcock is connected with this T arm, and the fluid (from the pipette) enters the glass tube, runs down along the walls of the tube, at the lower end of which it is collected as a fluid column which flows into the vein. (A wool thread in the glass tube, stretching

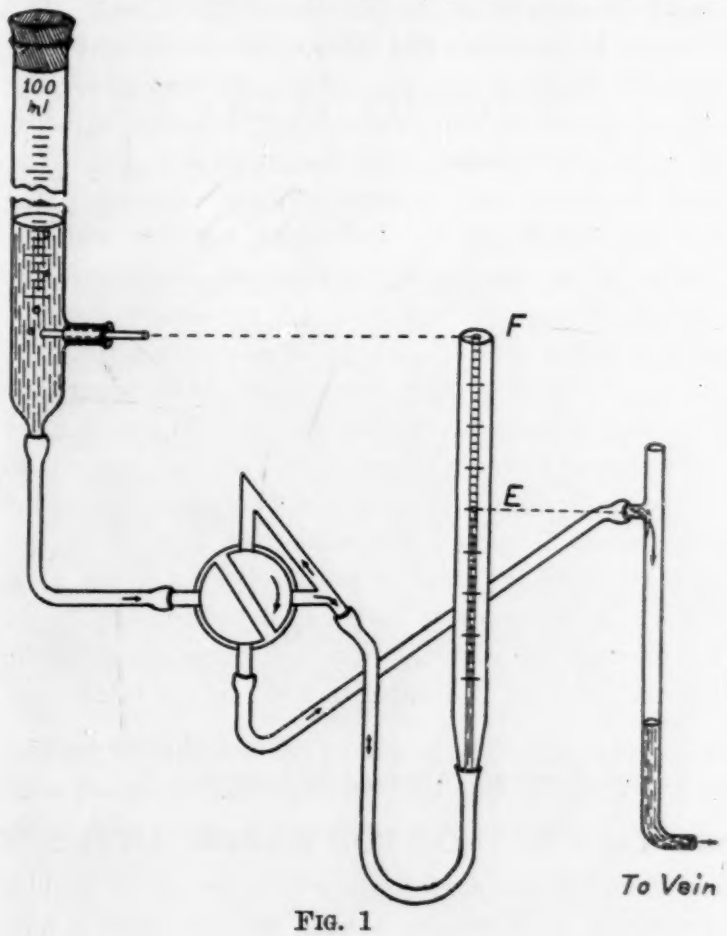

FIG. 1

[9] M. Sörensen and G. Haugaard, *Biochem. Zeit.*, 260: 247, 1933.

[1] Aided by a grant from the David Trautman Schwartz Research Fund and a grant to Dr. Erwin E. Nelson from the United States Pharmacopoeia XI Revision Committee.

[2] G. Katz, *Arch. Intern. Pharmacodyn. et Therap.*, 44: 1934, 239.

from the top to the bottom, helps to guide the fluid down and prevents it from clogging the narrow tube and enclosing air bubbles.) By completely exposing the vein to a length of 2–5 cm and using a canula with a fairly narrow opening, blood is prevented from entering the canula. The height of the fluid column is determined by venous pressure and canula resistance and obviously does not influence the inflow from the pipette into the open tube. Incidentally, since it follows venous pressure changes, it might be used to indicate a sharp endpoint in the digitalis assay; the ceasing of the heart action, by increasing the venous pressure, suddenly raises the fluid level; this is followed by a drop, representing the complete arrest of the heart.

The reservoir, which is a burette used as Mariotte-bottle and thus delivers under nearly constant pressure, and the pipette are clamped to one stand, which by means of a rack and pinion can be raised or lowered. The pipette is shortened by cutting it off at the zero level, where it is ground with emery. Its height is adjusted so that it is completely filled from the reservoir without overflowing, the surface tension provided by the dry, ground top preventing the fluid from leaving the lumen even when the air-inlet tube of the reservoir is somewhat above the zero level of the pipette. This preparation of the pipette eliminates a slightly inaccurate filling which would otherwise occasionally occur from the inflow disturbance caused by the air bubbles entering the Mariotte-burette. The venous inflow tube is clamped to a second stand, at a height determined by the position of the animal. The position of reservoir and pipette above the entrance point of the fluid into the inflow tube determines the emptying level of the pipette, which is easily adjusted by turning the pinion, with the motor running. The level to which the pipette empties represents the amount of fluid per "stroke" which, together with the number of revolutions of the stopcock, determines the amount infused per minute. (A revolution counter, driven by the stopcock, allows of calculating the total amount infused at any given time more accurately than can be done by reading the burette level.) The synchronous motor (Telechron, C2M) has one r.p.m. of the shaft, which, by means of two gears, drives the stopcock at 3 r.p.m.; this makes for 6 infusions per minute, which are more or less leveled out in the glass tube. The accuracy of the pump depends solely on the accuracy of the pipette. For our purposes, a "Kahn pipette" (0.2 ml, calibrated in 0.001 ml) is being used.

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AN EASY METHOD FOR MAKING AN INDEX

RECENTLY confronted again with the odious task of preparing an index for a book of more than a hundred pages, I sought for an easier method than writing the entries on twenty-six sheets lettered A to Z and then alphabetizing each sheet. I also wanted a less expensive and time-absorbing technique than using a separate filing card for each entry. The plan hit upon worked very well. Sheets of typewritter paper were fed into the typewriter. On each with double spacing were typed the needed entries, starting each entry on a new line:

Light for photosynthesis 95
Photosynthesis, light for 95
Transpired water 96
Water, transpired 96

With a photographic trimmer, the lines were later chopped apart and sorted into piles A to Z. A roll of Scotch tape was then partly unrolled, placed on the opposite side of the work table with the unwound part toward me, adhesive face up. The Z slips were arranged alphabetically and pressed to the nearer end of the tape, starting with the last of the group. Next the Y slips, and so on. The tape was later cut between slips at about eleven-inch intervals and made satisfactory copy for typing out the complete index, starting at Aa, the last slip fastened in place.

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BOOKS RECEIVED

Australasian Antarctic Expedition, 1911–14, Scientific Reports, Series C, Zoology and Botany; Vol. I, Part 3, Parasitic Infusoria from Macquarie Island, by T. Harvey Johnston. Pp. 12. 26 figures. 2/6–; *Vol. II, Part 4, Amphipoda Gammaridea,* by G. E. Nicholls. Pp. 145. 67 figures. 17/6–; *Part 8, Pycnogonida,* by Isabella Gordon. Pp. 40. 8 figures. 5/6–. Paisley, Sydney, Australia.

DIEBNER, KURT and EBERHARD GRASSMANN. *Künstliche Radioaktivität, Experimentelle Ergebnisse.* Pp. 87. S. Hirzel, Leipzig. 12.—.

JONES, INIGO. *The Climate of Australia during the Hypothetical Jovian Sunspot Cycle, 1913–1924, together with the Monthly and Annual Rainfall Observations.* Ninth Paper of the Crohamhurst Observatory. Pp. 111. The Observatory, Brisbane.

SMALL, LYNDON F. and others. *Studies on Drug Addiction with Special Reference to Chemical Structure of Opium Derivatives and Allied Synthetic Substances and their Physiological Action;* Supplement No. 138, *Public Health Reports.* Pp. viii + 143. Illustrated. Superintendent of Documents, Washington. $0.60.

STEWART, OSCAR M. *Physics; A Textbook for Colleges.* Third edition. Pp. x + 750. 500 figures. Ginn. $4.00.

SWIFT, ERNEST H. *A System of Chemical Analysis (Qualitative and Semi-Quantitative) for the Common Elements.* Pp. xx + 589. 32 figures. Prentice-Hall. $6.00.

TRAUB, HAMILTON P., Editor. *Herbertia, Volume 5.* Pp. 218. 2 figures. 34 plates. American Amaryllis Society, Orlando, Florida.

VOKES, HAROLD E. *Molluscan Faunas of the Domengine and Arroyo Hondo Formations of the California Eocene;* Vol. XXXVIII of the *Annals* of the New York Academy of Sciences. January 4, 1939. Pp. iii + 246. The Academy.